Hitchcock (C. H.)

REPORT

OF THE

GEOLOGICAL SURVEY

OF THE

STATE OF NEW HAMPSHIRE,

SHOWING ITS PROGRESS

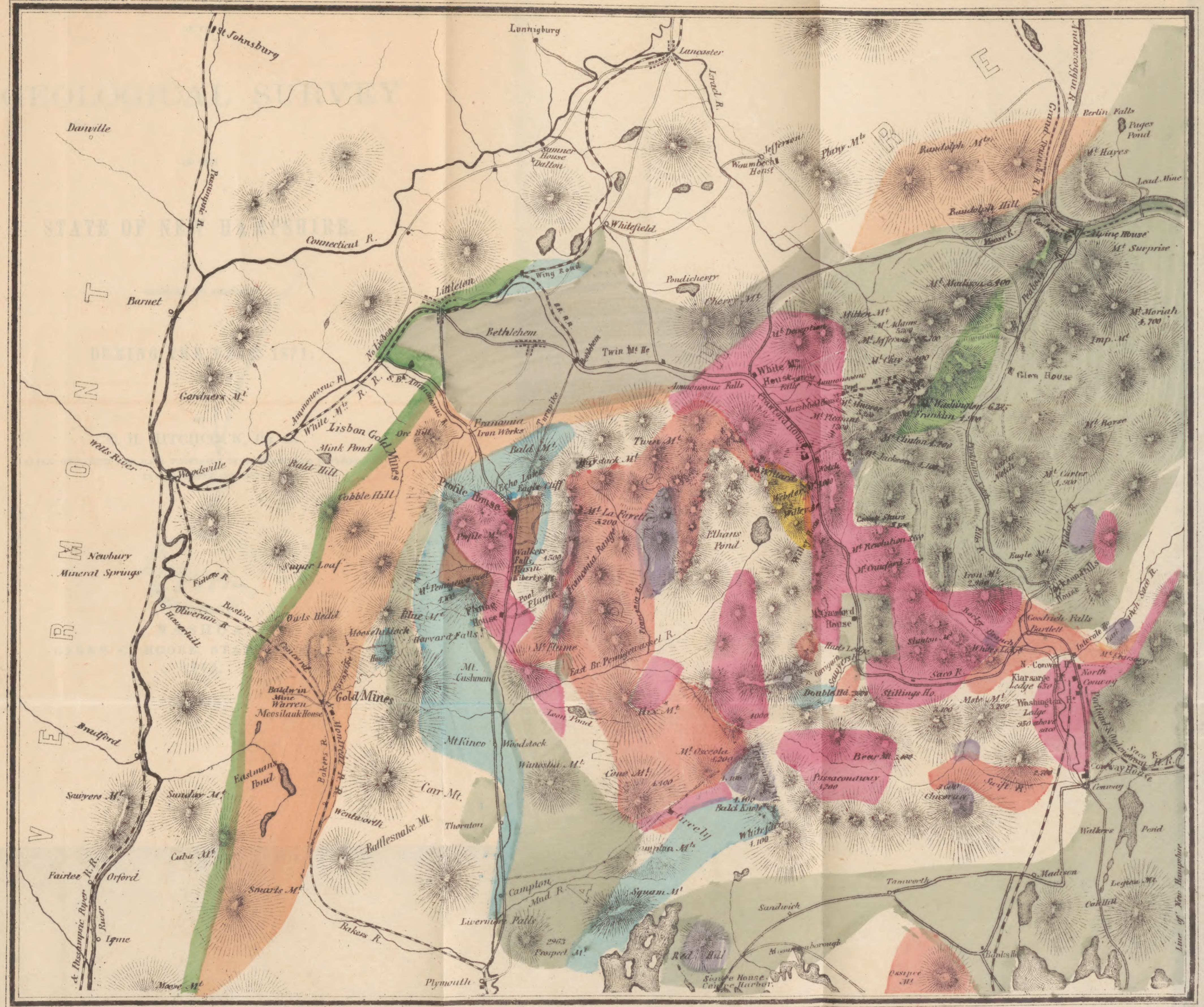
DURING THE YEAR 1871.

BY

C. H. HITCHCOCK, Ph. D.

STATE GEOLOGIST AND HALL PROFESSOR OF GEOLOGY AND MINERALOGY IN DARTMOUTH COLLEGE.

NASHUA:
ORREN C. MOORE, STATE PRINTER.
1872.



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EXPLANATION OF THE COLORS

- Porphyritic gneiss.
- Gneiss.
- Common granite.
- Brecciated granite.
- Clay slate & quartrite.
- Bethlehem gneiss.
- White Mt. or andalusite gneiss.
- Trachytic granite.
- Norian group, felsites & syenites.
- Coös group.

Prepared for Eastman's White Mountain Guide by C. H. V. Cavis.

SCALE OF MILES.

1 2 3 4 5 10

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STATE OF NEW HAMPSHIRE.

House of Representatives, June Session, 1872.

Ordered:

That the Clerk procure for the use of the House the usual number of printed copies of the Report of the Geological Survey of the State of New Hampshire.

Attest:

JAS. R. JACKSON, *Clerk.*

REPORT.

Hon. John H. Goodale, *Secretary of State:*—

Respected Sir:—I have the honor to present you herewith the Report of the operations of the Geological Survey during the year ending June 1, 1872. The full details, in accordance with the law establishing the Survey, are reserved for the final report.

The field operations were prosecuted vigorously during the whole of the summer season, chiefly in the more northern and southern portions, the former receiving the most attention. As the result, more information concerning the geological structure of the State has been acquired in the last summer's work than in all the previous seasons combined. As indicated in the last report, very diverse opinions respecting the age of the New Hampshire rocks have been entertained by the leading geologists of the country during the past thirty years. New interest has been given to the subject of New Hampshire Geology by allusions to it in the Presidential address of Dr. T. Sterry Hunt for 1871, before the American Association for the Advancement of Science—views which have called forth considerable opposition. It is believed that the key which shall unlock this mystery in Geology has been discovered the past season among our mountains.

The conclusions derived had been foreshadowed by our previous work, but they have been rendered much more satisfactory by the labors of the Survey in the Pemigewasset region, or the area lying between the Saco and Pemigewasset rivers and north of Sandwich. I do not need to add that all inferences concerning the kind and amount of valuable minerals likely to be found in our limits will depend upon the proper determination of the age of the formations, and on account of the practical results to be derived from our researches, attention has been directed primarily to the solution

of this question. In order to promote the early settlement of their relative ages, I present herewith a preliminary Geological map of the White Mountains which will enable you readily to perceive what districts contain the formations of greatest interest.

DESCRIPTION OF THE MAP.

The colors upon the accompanying map show the geographical relations of ten groups, so far as they are known. In the absence of precise knowledge, spaces have been left uncolored in certain districts. The topographical basis is the map of C. H. V. Cavis, prepared for Eastman's White Mountain Guide, upon the scale of five miles to the inch, it being the most convenient and accessible to us. On account of the difficulties in the way of exploring among the mountains, which have been described in previous reports, this delineation can only be regarded as a reconnoissance, especially as the true position of the rocks did not suggest itself till late the present spring, when the field notes were being compared with specimens. The next season's work may afford more precise data to theorize upon. The areas will be briefly mentioned, and the most important conclusions dwelt upon at length.

1. *Porphyritic Gneiss.* This is an ordinary gneiss, carrying numerous crystals of orthoclase or potash-feldspar, from a quarter of one to two inches long. The longer axes may be parallel to the strike, or arranged helter-skelter. It passes into granite with the same porphyritic peculiarity of structure. Its most northern area lies along the Ammonoosuc River in Bethlehem, Littleton and Whitefield. Next, commencing west of Haystack Mountain, at some unknown point, is another range, which passes southerly on the west flank of Profile Mountain and makes up the great mass of Kinsman or Blue Mountain; thence passes southerly to Woodstock and Campton. It crops out on the west side of Moosilauk — how extensively has never been determined. A spur from this appears at the Lake of the Clouds on Mount Lafayette, and passes southerly towards the Basin. It may occupy part of the uncolored area west of the Lafayette range. Upon the other side of the Pemigewasset country, this formation shows itself in the valley of Sawyer's River and on the south flank of Mount Carrigain. It is there covered by the norian. It reappears in Waterville, on Cascade Brook, Snow's Mountain, Bald Knob, and upon other high mountains in Sandwich, whence it passes out of the

limits of the map. We suppose this to be the oldest formation among the mountains. Geologists speak of a rock of this character as common in the laurentian in various parts of North America and Europe.

2. *Bethlehem Gneiss.* The whole of Bethlehem is underlaid by a gneiss abounding in a talcoid mineral, perhaps pinite. The orthoclase is abundant, usually pink or flesh color, and mica is sparsely disseminated through the rock. It is usually granitic, so much so that it has always been called granite heretofore. Its most remarkable feature consists in the common east and west strike between Littleton and Cherry Mountain. In Whitefield, Mr. Huntington finds the rock tending more northeasterly. Lying between outcrops of porphyritic gneiss the natural inference is that it is a synclical and therefore newer, while the strike indicates a very great antiquity judging from the same phenomenon elsewhere. The dip is monoclinal, averaging 75° northerly, across Bethlehem, but anticlinal in Whitefield. If the anticlinal structure is persistent, evidence may be afforded that this peculiar gneiss is older than No. 1. There is a limited outlier of this rock west of Haystack Mountain, another northwest of Mount Pemigewasset, a third about Big Coolidge Mountain in Franconia, and perhaps another south of the East Branch of the Pemigewasset. These limited outliers give the idea of a rock newer than number one. The boulders scattered to the north of Lafayette in Franconia and Bethlehem, which Professor Agassiz regards as moraines of a local glacier pushing northerly, are composed of this rock.

3. *Gneiss.* The gneiss west of number one in Franconia and Landaff, and also to a limited extent east of the Norian on Tripyramid, is a common variety, and has not yet been referred to any of the sub-divisions recognized elsewhere.

4. *White Mountain or Andalusite Gneiss.* This is the variety described in previous reports as containing andalusite or staurolite. It occupies the great part of the White Mountain area east of the Saco, making up the bulk of the highest peaks. It reappears on equally extended a scale south of Mounts Kiarsarge, Chocorua and Whiteface. About Dr. Bemis's residence, or the "Mount Crawford House" of the map, this rock seems to be isolated, being surrounded by granite. A little of it lies to the north of the norian in Albany, and is not represented upon the map. Further north it crops out in Whitefield, and there is a range ap-

parently from the west flank of Profile Mountain to Moosilauk. More is found in Thornton, and there is an extensive area of it to the southwest which is not designated upon the map. The presumption is that the beryl-bearing gneiss east of the Pemigewasset on the edge of Woodstock and Thornton is the same rock, extending into Campton. The amount of andalusite in this area is very small. The relative position of the andalusite gneiss remains to be determined. It seems to be newer than Nos. 1 and 2, but the relations to the granites and norian are yet to be made out.

5. *Common Granite.* The type of this rock appears at the Basin, Pool and Flume in Franconia, and at Goodrich's Falls in Jackson. The constituents are rather coarse, never more than an inch and usually one fourth of an inch long. The orthoclase is commonly flesh-colored and the most abundant ingredient. The quartz is smoky, translucent, and often roughly crystalized. The mica is the least abundant of the three constituents, and is black. The joints passing through this rock are both horizontal and vertical. This rock seems to form the basis of the whole Pemigewasset country and the areas left blank will most likely be found to consist of this same material. The first area is that in Franconia, embracing the Profile and Cannon Mountains besides the parts already specified. The mountains show a finer-grained rock than the valleys. Some of it seems to extend into the uncolored area between No. 1 and the Lafayette range. This probably connects under Flume Mountain with the granites on the East Branch in Lincoln and Thornton. More appears near the forks of the East Branch, Hancock Mountain and the ridge north, including the "Falls," in the valley of Mad River in Waterville, abundantly in the Swift River Valley in Albany, and about Conway, passing under Kiarsarge and extending into the Green Hills. The small area of Bald Face and Mount Eastman in Chatham has a fine grain and possibly is of a different age.

The largest area of this rock upon the map extends from Jackson to Carroll. The Saco valley above Rocky Branch is mostly excavated out of it. The excavation of the White Mountain Notch out of this granite was alluded to last year. The high range north from Mount Lowell to Mount Willard is probably of this rock. East of the Saco the andalusite gneiss seems to have been cut by it, Mounts Crawford and Resolution being composed of granite. Mount Deception and the country east of the old Fab-

yan House is made up of a different sort of a granite, whitish or grayish in color, with the feldspar in narrow crystals, porphyritic in appearance. But the range from the north end of Mount Tom to the Lower Falls on the Ammonoosuc, and the three "Sugar Loaves" farther west, are entirely of the typical variety of coarse granite.

6. *Trachytic Granite.* Above No. 5, with the same horizontal appearance, is a granite of trachytic or semi-porphyritic aspect. The feldspar is orthoclase, as shown by Analysis XL., and most of the rock is made of it as rounded crystals imbedded in a granitic paste, with scarcely any quartz. Feldspar and a dark mica may be discerned. It often contains a small per cent. of manganese. The first great expanse of this rock lies between the sawmill of Rounsevel and Coburn, in Carroll, on the Ammonoosuc, and Waterville. The Twin Mountains, Haystack, a portion of the Lafayette range beneath the cap, Mounts Liberty, Osceola, and other high peaks, are mainly composed of this trachytic granite. It will be observed that this area is wholly in the forest region, untraversed by roads; hence it is not strange that its peculiar characters should not have been recognized earlier. There is some of this rock north of Mount Carrigain, and the Sawyer's Rock range appears to belong here. Other localities are high up Rocky Branch in Bartlett, Iron Mountain, the valley of the Saco in Bartlett, underlying the great mass of Kiarsarge, but above the common granite. The rock referred to this division, along the Swift River and the Ossipee mountains, is made of finer materials, with more of the paste, and that of a darker color than the ledges further west. It also disintegrates less readily.

7. *Brecciated Granite.* This designation applies to brecciated masses, often of large fragments, in Franconia, forming Eagle Cliff, and several nameless peaks between Profile and Kinsman. The fragments most easily recognized are those of porphyitic gneiss, dark gneiss and hornblende, imbedded in a very compact feldspathic paste. Along Eagle Cliff there are appearances of stratification, and at Echo Lake the brecciated granite appears to underlie the porphyritic gneiss. The rock is irregular in arrangement as if thrust up from below. As it contains no fragment of the common and trachytic granite, we have concluded it to be more ancient than either of these granites, but newer than the porphyritic gneiss. The two areas are also probably connected

beneath the Pemigewasset valley, under the common coarse granite, which either flowed in above the breccia or was deposited upon it quietly in some other way.

8. *Norian*. This includes several areas of labradorite rock, including compact felsites, breccias and syenites. They are the Lafayette range, Twin Mountain area, near Loon Pond, Tripyramid region, Carrigain district, north of Mount Tom, Valley of Dry river, Valley of Rocky Branch, Sable Mountain in Jackson, Mount Kiarsarge or Pequawket, Deer river valley of Albany, near Mount Chocorua, and Red Hill, Moultonboro'. There are other areas to be referred to the same group outside of the White Mountain area. These rocks are elsewhere described in as much detail as is best.

9. *Clay, Slate and Quartzites*. The first of these areas is a limited one on the south slope of Kiarsarge; the second southwest of Mount Willard, passing into andalusite slates and quartzites on Mounts Willey, Lincoln and Tom.

10. *Coös Group*. This embraces the andalusite slates on the east flank of the Mount Washington range, repeated on the north east side of Camel's Hump near Gorham, and the staurolite rocks from Littleton southwards, curving around the underlying Bethlehem gneiss. Only the eastern border of the latter is indicated upon the map.

NORITE ROCKS.

Our conclusions as to the absolute and relative ages of the New Hampshire formations depend upon the reference of some of them to the Norian system of Hunt. As this term is doubtless entirely new to you, I may be excused for referring to the reasons which call it forth.

The older geologists regarded all the crystalline rocks as those first formed or "primary." The granites were considered as remains of the original crust, cooled down from the condition of intense fusion, and the gneiss, mica schists, etc., resulted from the action of eroding agencies, tearing off fragments of the granites and depositing them in the lower areas. These unstratified and stratified rocks have also been styled *Azoic*, from the supposed absence of life in these early periods. Only lithological names had been applied to the different Azoic rocks till 1855* when Sir W. E. Logan proposed that the Azoic formations in Canada be-

* Esquisse Geologique du Canada.

neath the Potsdam sandstone should receive local appellations, and he accordingly separated them into two groups, calling the older *Laurentian* and the newer *Huronian*. These terms expressly excluded the Azoic rocks of New England which by many authors had already been considered to be of Paleozoic age. So early as 1845 Logan perceived that the gneiss of Canada, afterwards termed laurentian, could be divided into two groups, dependent upon the presence or absence of beds of limestone, and in 1857* suggested that such a subdivision would probably be found desirable. The studies of Dr. Hunt from 1852 onwards upon the feldspars led him also to suspect the truth of this classification of the laurentian, the lime-feldspars being assigned to another group than that carrying the limestones. In the report upon the Geology of Canada for 1863,† great vertical thicknesses of the laurentian gneiss are distinguished mineralogically from the others by the presence of triclinic-feldspars, and the rocks termed *anorthosites*. Later in the same volume certain facts are stated rendering it probable that the anothrosite series unconformably overlies the gneiss having beds of limestone in it.‡ The formal proposal of this subdivision is presented in the atlas accompanying this report issued in 1865, where the anorthosite group is distinguished as the *Upper Laurentian* or *Labrador* series, and the other the Lower Laurentian. The nomenclature of this atlas is based upon further exploration. Had this not been satisfactory the distinction in the atlas would not have been delineated. The evidences of unconformity consist in the concealment of beds of limestone by the upper rocks covering them and the change of strike. The testimony of Mr. James Richardson to the relations of the Lower and Upper Laurentian on the north shore of the St. Lawrence in 1869 confirms the reality of the division. He represents the dip of the laurentian to be nearly vertical with a north and south strike, while the labradorite rocks dip at comparatively moderate angles with a strike nearly east and west.§ This separation of the laurentian into two systems has not been observed in other countries, or by other surveys than the Canadian, and hence geologists are not yet all satisfied with the correctness of the conclusions. But all will agree that the mineral labradorite belongs to the original lauren-

* Proc. Amer. Asso. Adv. Sci., Vol. XI, p. 47.
† p. 22, 33, 478, 586. ‡ p. 839.
§ Geol. Survey of Canada, Report 1866-9, p. 306.

tian system, and therefore by its discovery in New Hampshire, will be satisfied that some of our crystalline rocks belong to the older series of the Eozoic, and not the Paleozoic. Hence the prevalent opinion respecting the age of the New England metamorphic rocks must be changed to conform with the discovery of labradorite in our state. The various opinions respecting the age of the White Mountains were alluded to last year.

Dr. Hunt in 1870 recalled the fact that the term Norite had been applied to rocks containing the lime feldspars before Labradorite; and therefore proposed the term *Norian* (from Norway) to take the place of Labradorian for the system. He calls attention to these rocks in a paper before the American Association for the Advancement of Science in 1869, which was reprinted in the "American Journal of Science." The system, if it be a system, is yet to be explored carefully; for we do not know its thickness, the various schists which naturally compose it, nor its proper relations to the Huronian. We may hope that the Pemigewasset country will hereafter afford some of these greatly to be desired details.

As our conclusions are based upon the existence of labradorite in our limits, it may be best to describe its principal localities.

LABRADORITE IN WATERVILLE.

Near the east line of the town of Waterville is a high mountain, called "Tripyramid," for the reason that from an oval base three conical peaks rise to nearly the same height, the highest being 4086 feet (Guyot) above mean tide water. The course of these summits is ten or fifteen degrees west of north. From Chocorua and Kiarsarge Mountains the northern cone is farther away from the middle than the southern one, and there are two subordinate elevations each side of the centre. Bond gives four peaks on his map corresponding to Tripyramid, the two southern 4400 feet each, the others 4300 and 4000 feet above the sea. The whole mountain mass is isolated and is therefore quite prominent. The southern peak is about three miles westerly from Passaconaway in Albany, and four from Whiteface in Sandwich, both of nearly the same altitude; while Osceola, on the boundary line between Waterville and Allen's Grants, is 4397 feet above the ocean, and not less than six miles away. The Grafton county map improperly calls Tripyramid Passaconaway, and misled by this authority many persons have fallen into error in their descriptions of localities.

The notable storm ending Oct. 4, 1869, gave rise to a remarkable freshet upon the southwestern slope of the most southern of these pyramids. The mountain side seems to have been covered by spruces growing above loose blocks carpeted abundantly with moss, very much as is common all over the White Hills wherever the climate permits temperate vegetation to flourish. No valley furrowed the slope, and it seems difficult to understand why the waters should have accumulated so enormously at this point, and nowhere else in the neighborhood if we may judge by the effect produced; especially since the bare mountain side exposed at this time has rendered the area conspicuous as a landmark fifty miles away. It were easy to imagine that some atmospheric disturbances had collected the waters for a circle having a diameter of a mile, and discharged them in a narrow stream upon the forest beneath. Clouds are sometimes said to "burst" when their contents are poured very quickly into some limited area, most usually when a tornado or rapidly formed cimbus flits by, yet something of a similar character will best explain the phenomena displayed in Waterville during this never-to-be-forgotten storm.

Almost immediately after the storm this locality was visited by Prof. G. H. Perkins, Ph.D. of the University of Vermont, Rev. M. T. Runnells of Sanbornton, and Charles Cutter of Campton. Prof. Perkins wrote a description of the changes wrought in the country and published it in the "American Journal of Science" (II. Vol. XLIX., p. 158). As he made careful estimates of distances in the upper part of the mountain, I will use his figures in the paragraph that follows.

The sliding commenced about forty rods from the summit, a little one side of the highest point. The beginning of the bare earth is only a rod in width. The breadth increases gradually for fifty or sixty rods. For the following seventy rods down hill it widens rapidly, attaining at one hundred and thirty rods distance a width of twenty-five or thirty rods. Thirty-six rods lower the breadth is seventeen rods. The course is nearly straight to this point—one hundred and sixty-six rods, where it begins to curve towards the northwest instead of continuing southwesterly, and eighty rods below is what Prof. Perkins regarded as a termination of the slide. The waters excavated a gorge through the boulder-clay or "hardpan" of the country after passing the elbow, often twenty-five feet deep, the material being almost as firm as solid rock. The whole

course thus far mentioned is two hundred and forty-six rods, of a general fusiform outline with the lower end curved to one side. The inclination of the debris is often as much as forty-five degrees, perhaps higher for a dozen yards, and generally somewhat less. The underlying ledges appear in two or three places, but do not exhibit any marks or scratches made by the sliding mass.

The curve of the bottom of the hill is nearly a right angle and was determined by the configuration of the land, for directly in the way of the slip there is a low ridge covered by a forest. Were the phenomenon a true slide the materials must have been arrested by this obstacle. But no more earth lies before this obstruction than along any part of the two or three miles distance of the steepest descent below. The forest must therefore have been torn up by a prodigious freshet, trees, earth and rock fragments mingling with the water as if all a liquid mass, winding through the curved valley of a stream and excavating a deeper channel below the turn in its direction. In a clearing of fifty acres at the base of the mountain, called "Beckytown," great piles of rubbish, rocks and trees accumulated, while only earth was transported farther.

For nearly two miles below the elbow mentioned above the current descended rapidly, occasionally depositing gravel in protected nooks, which with their sloping surfaces may be called terraces. Quite high up is an interesting excavation in the form of a notch, where one side is long, sloping gradually, and the other steep and short. Half way down the stream—which may appropriately be termed Norway Brook on account of the name of the formations traversed by it—the water falls precipitately over a ledge of the dark norite rock. Elsewhere the valley is like that of any mountain torrent.

This locality is easily accessible. During the summer a stage runs from Plymouth to Greely's Hotel in Waterville, a distance of twenty miles. From this summer resort the first of the norite ledges is less than two miles, over a well defined footpath, and passing near a picturesque cataract. Mr Greely can direct visitors to these rocks.

The locality was first visited in a scientific way by Dr. Perkins in 1869, who did not recognize the Labrador feldspar. In May, 1870, Mr. J. H. Huntington went up the stream, bringing back specimens of the dark rock which he suspected might be labradorite.

He carried a fragment of it to Dr. T. Sterry Hunt of Montreal, for examination. Dr. Hunt's analysis showed the predominant mineral to be labradorite, in a letter dated March 21st, 1871, and addressed to Mr. Huntington. Not being aware of the existence of this letter, I quoted from another letter of Dr. Hunt's, addressed to myself, and written about the same time, the following sentence, which was printed in a brief communication concerning the "Norian rocks in New Hampshire" in the January number of the "American Journal of Science," 1872. "The specimen brought by Mr. Huntington is a labradorite or norite rock, which resembles in composition and aspect that of the labradorian; with this difference, however, that it is much more tender and friable, and in this respect resembles the granitic gneiss of the White Mountains, as compared with similar rocks in the Adirondacks." I regret exceedingly not to have been made acquainted with the other letter, and therefore am very glad to furnish the following from Dr. Hunt of a later date, in which he directs attention to the omission of his analysis, and mentions other points of interest respecting the minerals.

My Dear Prof. Hitchcock:—In your note in the "American Journal of Science" for Jan. 1872, (p. 44) on the presence of labradorite rocks in New Hampshire, you quote from a letter of mine to Mr. J. H. Huntington, dated March 21, 1871, in which I pointed out that the rock from Waterville was a labradorite or norite; and you subsequently refer to the analysis of Mr. E. S. Dana in the same number of the Journal, as confirming my opinion, and as showing that the rock consists essentially of a feldspar allied to labradorite, together with a portion of titaniferous magnetic iron, and grains of chrysolite.

A further reference to my letter above noticed, would have shown that I had already analyzed the rock, and examined the associated iron ore. I there wrote as follows: "The blue granular crystalline rock from Waterville, N. H., consists chiefly of a feldspar allied to labradorite. I have not separated the grains to get them quite pure, but the mass is seen under a glass to consist of the bluish-grey cleavable-feldspar, with some mica, probably biotite, and a little magnetic iron ore. From a pulverized sample the magnet takes up about 5 per ct. of magnetic grains: these contain a little titanium. The analysis of the material thus freed from the magnetic portion gave me: silica, 50.30; alumina, 25.10; protoxide of iron, 4.23; lime, 14.07; magnesia, 2.95; volatile, 0.70: loss (alkalies) 2.65—100.00. I have found the feldspar of the so-called labradorite or norite rocks very variable in composition, being sometimes more and other times less basic than typical labradorite." "The analysis agrees closely with what might be expected from an admixture of labradorite with biotite. It (the rock) may hold a little hornblende, but I did not discern any. Thus the rock agrees chemically and mineralogically with much of the norite

of the labradorite series of rocks, in which titaniferous iron and biotite not unfrequently occur."

I did not observe any chrysolite in the specimen examined by me, nor, on the other hand, did Mr. Dana find any biotite, showing some little variety in the norite, from this locality. He remarks that a rock consisting of labrador with chrysolite (olivine) has not been previously described. It was however long since noticed by McCulloch, in Skye, and by G. Rose at Elfdalen. [Senft *die Felsarten;* also Geology of Canada, p. 650.]

I may here mention that with the great masses of titaniferous iron ore found in the Black Hills in Colorado, there occurs a very characteristic coarsely-granitoid lavender blue norite; specimens of which were brought me last year by Prof. Richards of the Massachusetts Institute of Technology.

Yours very faithfully,

T. STERRY HUNT.

MONTREAL, May 1st, 1872.

The substance of this note having been communicated to Mr. Dana, the following letter came from his father.

PROF. C. H. HITCHCOCK. *My Dear Sir:*—In the absence of my son, Mr. Edward S. Dana, now on his way to Europe, I write a brief reply to your letter of the 29th inst. You stated that Prof. T. Sterry Hunt, in a recent note, objects to Mr. Dana's remark that a rock of the composition of the ossipyte of Waterville had not before been described, and that he refers to Macculloch as having observed the same in Skye, and G. Rose, another example of it at Elfdalen in Sweden. Mr. Hunt is evidently unaware of the facts. Macculloch found chrysolite in Skye, according to his two articles in Vol. III. and IV. of the Transactions of the Geological Society of London, only in trap or "amygdaloid;" and he repeats the same essentially in his work on rocks, the chrysolite being spoken of as occurring in an eruptive or overlying rock. Greg and Lettsom, in their work on British Mineralogy (1858), confirm this by speaking of the chrysolite of Skye as being found in *trap*. Moreover the chrysolite is one of three constituents: the other two being hornblende or augite, and a feldspar; and the rock is not laurentian or norian.

The rock of Elfdalen is undoubtedly related to that of Waterville, and yet is widely different. I have not seen Rose's description of it. But Senft, to whom Mr. Hunt refers, speaks of it as a hypersthene rock, that is, a granular compound of labradorite and hypersthene, with grains of chrysolite as an accessory ingredient. The ossipyte, on the contrary, consists almost solely of labradorite and chrysolite, there being "only a very little of a black mineral, probably hornblende." I examined the specimens of ossipyte with Mr. Dana, the same that I collected when in Waterville with you, and through much of it could detect no hornblende whatever. Mr. Dana was right, therefore, in saying that this Waterville rock, consisting essentially of labradorite and chrysolite, is one not previously described. The principal constituent, besides the two mentioned, was the titaniferous iron one, which he found distributed in microscopic grains through the labradorite.

The light colored rock from a point higher up the stream, determined to be

a Labradorite rock by Mr. Dana, is, as he observes, wholly different from the ossipyte, it containing much hornblende and no chrysolite, and the titaniferous iron ore in visible grains instead of invisible particles disseminated through the labradorite.

The analysis of the Waterville labradorite, by Mr. Hunt, of which you send a copy, takes no note of the fact that the mineral is full of disseminated grains of titaniferous iron ore, as above remarked. The presence of this mineral may in part account for the large percentage of iron obtained in his analysis.

Yours truly,

JAMES D. DANA.

I first visited the locality August 18 and 19, 1871, and subsequently on Sept. 20, in company with Prof. J. D. Dana. As already intimated, I furnished a short article, descriptive chiefly of this locality, for the "American Journal of Science," January, 1872, and Mr. E. S. Dana followed with analyses of the feldspar and chrysolite, the specimens having been obtained by his father on the twentieth of September. The discoveries made since that time will be noticed presently.

In ascending from Beckytown, the first rock seen was called gneiss with nodular orthoclase, with its supposed strata dipping by compass 80° S. 70° W. This rock is evidently the same with the "Trachytic granite" of Mount Osceola and elsewhere. After noticing its distribution in mass throughout so large a portion of the Mountains, and its nearly horizontal position between the coarse granite below and the felsites above, the presumption arises that these so-called strata may be bands of mica whose planes do not correspond with those of accumulation, but have been superinduced during the metamorphism of the rock. The jointed planes dipping about 25° westerly would be those of stratification, if the rock is stratified. These were pointed out by J. P. Lesley.*

A few rods up Norway Brook appears the first ledge of the Ossipyte. Its junction with the gneiss is concealed by drift. For about a mile similar ledges occur, some exposures being sixty or seventy feet long. Considered as an isolated case it is difficult to determine the planes of stratification since two prominent sets of jointed planes exist, either of which might be taken for strata. One set dip about 20° northerly, and are the most numerous. The other dip about 75° W. 10° S. As the latter correspond better in position with the supposed strata of nodular gneiss, it was thought they indicated the proper lines of deposition. The former, how-

*Proc. Amer. Acad. Sci., Philadelphia, 1860, p. 363.

ever, are what appear at the first glance to be the strata, and as by this interpretation the position of the rocks at Waterville will correspond with that in Franconia about the Lafayette range, our former ideas must be modified. We should have therefore an underlying granite as seen in Mad River two miles below Greely's Hotel, then the trachytic granite of Osceola, extending to the cascades and including the "nodular gneiss" on Norway brook, dipping gently westerly, and finally above both the ossipyte schists, with a small inclination. Analyses I., III. and XIII., are of minerals from the norite bands.

The ossipyte is abruptly succeeded by the gray rock called syenitic, being sometimes labradorite with hornblende and some mica, then orthoclase, labradorite and mica with scarcely any hornblende. The line of junction is irregular, averaging the course N. 20° E., while the dip of the plane of separation is about 85° westerly. Some of this feldspathic rock has been injected into irregular cavities of the norite. The general impression is that the syenite was an eruptive rock, cutting nearly vertically across the norite.

Perhaps an eighth of a mile above this junction the interesting assemblage of coarse crystals of whitish labradorite, hornblende, titanic iron, mica and epidote (see Analysis II.) occurs at the "Notch." These ledges disintegrate very rapidly. Large nodules of the syenitic rock less liable to decomposition are scattered through the mass; and there are geodic cavities containing orthoclase, albite, quartz, and rarely stilbite. The "Notch" is produced by the erosion of a ferruginous band, resembling a stratum, and dipping both E. 15° S. and E. 85° N. Above the notch, as far as the "Elbow," there is a recurrence of the fine-grained syenite, containing geodes and feldspathic veins. At the Elbow there is a somewhat different mineral combination, extending to the top of the Pyramid. Quartz is rare, but there are two kinds of feldspar. Mica is abundant and some specimens show hornblende. The same minerals occur in the geodic masses as below, also actinolite, amethyst, and others yet undetermined. Analyses IV. and VII. show the composition of one of these feldspars—being suggestive of Andesite.

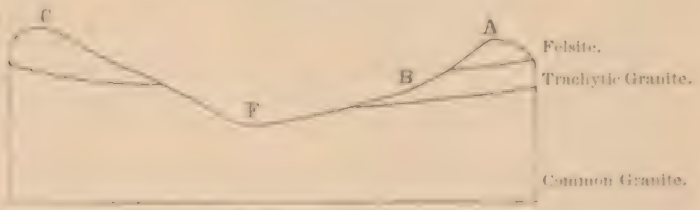
The area colored as norian upon the map includes the ossipyte and various syenitic rocks about the whole of Tripyramid. Upon the north-east side Mr. Huntington found a similar order of ledges

in ascending that tributary of Swift River called Sabba Day brook. Near the mouth of the stream there is a cataract falling over the common granite of the country. The same appears a mile higher up. The same rock is found on Downs's Brook, another tributary of Swift River, running very nearly along the line between Waterville and Albany. The trachytic granite was not observed here, possibly because we had not learned the importance of distinguishing it at the time of the visit. But higher up Sabba Day brook Mr. Huntington found compact labradorite in place apparently devoid of chrysolite, and fragments whose cleavable crystals displayed the play of colors usually seen in this species. Higher up the mountain, the north Tripyramid, the syenitic rocks of the slide reappear. Farther south the labradorite passes into a breccia apparently overlying gneiss. The rocks adjacent to this norian area are the trachytic granite at the base of Tripyramid on Norway brook, and probably on the north, since specimens of it have been brought from the Flume upon Flume brook, nearly two miles distant; common granite to the northeast, gneiss on the east and porphyritic gneiss upon the south. Concerning the latter an additional word of explanation can be given. There is a low ridge between Norway and Cascade brooks, the latter being about a mile distant from the former and essentially parallel to it. First we see the trachytic granite at the "Cascades," whose position is essentially like that just below the ossipyte. Above that for a mile's distance or more, I followed up the stream over ledges of porphyritic gneiss, much disturbed, but with the dip of 75° N. 20° E. most common. The hill between the streams was not examined, but if the position of the ossipyte remains uniform, it must be underlaid uncomformably by the porphyritic gneiss. This latter rock is very extensive. The ledges upon Cascade brook seem to be the northern end of continuous exposures all the way from Fitzwilliam, if not from southern Massachusetts, a distance of ninety miles, and sometimes a breadth of fifteen.

THE LAFAYETTE RANGE.

From a peak north of Mount Lafayette in Franconia to Flume Mountain there seems to be a nearly continuous band of dark, compact feldspar, about five miles long, and never more than two hundred to three hundred feet thick. It closely resembles some of the compact labradorites (see Analysis XVI). The layers are hori-

zontal or slightly inclined to any point of the compass, resting upon trachytic granite throughout. It has not actually been traversed from the south end of the Lafayette ridge to Flume Mountain, but the topographical features of the country are such as to render probable its continuance by a curve to connect with that which has been observed upon the latter summit. The annexed wood-cut will show the relative position and thickness of the rocks between Mount Liberty (C), and Mount Flume (A), two thousand two hundred and fifty feet above the bottom of the valley. There is the common coarse granite at the base, the celebrated Flume of Lincoln (Franconia), lying at the bottom of the valley, (F in the figure) eighteen hundred and forty-nine feet above the ocean. Above the Pemigewasset river there may be six hundred feet thickness of this rock, considering it to lie horizontally, before reaching the trachytic variety. This in turn may be one thousand feet thick. This rock caps Mount Liberty, but the compact feldspar has been spared by the denuding agencies upon Mount Flume. As seen by the general map the edges of this dark rock everywhere rest upon the trachytic granite.



OTHER LOCALITIES.

There seems to be an extensive mass of this dark rock associated with a red felsite east of Franconia Branch. The latter rock was at first thought to be jasper, but its analysis shows it to be orthoclase. The dark variety is the same with that analysed by Prof. Seeley (VII.), the label being "a boulder from Waterville." One of the red boulders from the same locality, (Analysis XV.) seems to be the same rock with that in place in Albany (Analysis XIV). The analyses show that these felsites are related to orthoclase more nearly than to any other feldspars. The iron is more abundant than usual in both kinds. The comparatively large amount of lime and magnesia is worthy of consideration,

and may be explained by its nearness to labradorite stratigraphically. Both overlie the trachytic granite and would seem to belong to the same formation, be it norian or laurentian. The Berlin felsite (VIII.) corresponds well with the others so far as the constituents have been determined. This comes from a different horizon, from a hornblende gneiss north of the White Mountains.

The felsite near Loon Pond in Woodstock is like that capping Lafayette. It is very limited in extent, and does not rise so high topographically as the trachytic granite to the east. Mount Carrigain is largely composed of felsite, often porphyritic, apparently orthoclase, judging without analysis. This is an isolated peak, four thousand six hundred and seventy-eight feet high, with trachytic granite joining the felsites on the north, the White Mountain gneiss on the east, porphyritic gneiss on the south, common granite on the west. Ascending the east spur from Carrigain brook one finds the strata dipping first northerly and then southerly towards the centre of the peak. Descending towards the headwaters of Sawyer's River on the southwest side of the east spur, the strata have been much distorted and faulted, highly inclined and nearly horizontal layers nearly touching each other. The rock on the highest peaks is different, evidently approaching the trachytic granite in character. So much fine dark mineral is present as to produce a grey color when weathered. The adjacent ledges would indicate that the Carrigain rocks are allied to the compact felsites of Lafayette, etc., in position.

A trip northward from Mount Tom, west of the Crawford House, resulted in the discovery of compact labradorite. Another excursion in 1870, along the Dry or Mount Washington River, east of the Saco, led to a similar discovery (Analysis XVII). The specimens were laid aside and forgotten till the discovery of the Waterville labradorite called attention to them. The same was true of specimens from Rocky Branch, most of which are of a coarse breccia. The first are situated in the midst of the White Mountain gneiss, less than five miles from the summit of Mount Washington. The study of this locality will certainly throw light upon the age of the schists, if the occurrence of the lime feldspar is indicative of geological age.

Two groups of strata occur at Sable Mountain in Jackson. Most of the area is a coarse breccia, and that on the west side ap-

pears like a compact labradorite. They are encircled by the White Mountain schists. Some of the rock at the tin mine resembles the syenitic rocks of Tripyramid. Mount Pequawket or Kiarsarge shows a feldspathic rock in its upper portions which seem to overlie a trachytic and common granite, and therefore to have the same stratigraphical position with the felsites above enumerated. Upon Deer River in Albany an interesting series of specimens has been obtained by Mr. Huntington. At Swift River and for half a mile north is found the modified trachytic granite, mostly orthoclase. Next appears a gray conglomerate of very small pebbles, containing also crystals of feldspar. Boulders of a similar rock were collected at Waterville. North of this comes dark felsites like those from Pemigewasset (Analysis VII.), breccias and trappean rocks verging into porphyry. Next is a coarse breccia composed of light and dark orthoclase felsites and fragments of labradorite, judging by the eye. Then succeed red compact felsites (Analysis XIV). Mr. Huntington traveled one or two hundred rods above these feldspathic rocks, and found only a schist resembling the White Mountain gneiss to the north. Between this point and the Saco Valley in Bartlett is a high mountain range which has not yet been explored. The rocks along the Saco are common granite. Mr. Huntington has also found an abundance of what seems to be labradorite upon Mount Chocorua, in the southeast part of Albany.

Red Hill in Moultonboro' and Sandwich is composed of a syenitic rock so similar to that associated with norite as to suggest a corresponding position. The syenitic area is elliptical, say three and a half miles long by one and a half wide, the eastern summit being seventeen hundred and sixty-nine and the western two thousand and twenty-five feet above tide water. It is entirely surrounded by a granitic gneiss, distinctly stratified, easily decomposing, carrying granitic veins holding beryl, and recognized most readily by the common fact of showing on worn surfaces reticulated segregated veins. The junction of the gneiss and syenite was observed at the north end of the latter. The gneiss dipped southerly at a high angle, and the syenite lay upon it. On the west side the relations of the two are the same, the gneiss dipping south of east, being nearly vertical. Upon the east side the strata dip equally high in the opposite direction, or toward Red Hill. Thus the syenite would seem to lie in a synclinal axis. Nothing

like stratification could be discerned in the upper rock. We may suppose it to be eruptive like that on Tripyramid. Small dikes of rock resembling labradorite cross the gneiss in Sandwich one or two hundred feet north of the syenite. Observations upon Mounts Gunstock and Belknap in Gilford brought to light immense masses of syenite and breccias, reminding one of Tripyramid. The same can be said of the mountains between Lancaster and the Grand Trunk Railroad, which are out of the limits of our map, else they would be described.

PROFESSOR VOSE'S REPORT.

In 1869 Mr. George L. Vose, since appointed Professor of Engineering at Bowdoin College, Brunswick, Maine, acted for a few weeks as an assistant upon the Geological survey. His geological researches extended over a part of the field now being described, and therefore I will present his report at this time, rather than reserve it for publication hereafter, as was intended. I have added in brackets the names of the rock to which he refers, to correspond with the usage of my own report.

PARIS, Me., Aug. 3d, 1869.

PROF. C. H. HITCHCOCK, *State Geologist of New Hampshire:*

MY DEAR SIR,—I have spent the month of July in examining the topography and geology of some portions of the towns of Jackson, Bartlett, Conway and Tamworth, and send herewith such information as I have obtained. The two packages of rocks forwarded to you at Hanover, with the tracings and the list at the end of this letter, will give you some idea of the character of the district.

At the west end of Ossipee Mount (see tracing No. 1), we find a rock like Nos. 43, 44, 45, [trachytic granite] apparently arranged in thick beds, running about N. W. and S. E., and dipping about 30° N. E. Just below the bridge, east of the church, at South Tamworth, and from that point to the Bearcamp, we find the rock No. 48 [Bethlehem gneiss?], in regular beds from one to six inches, and over, in thickness, running E. and W. and dipping about 20° N. A little lower down the Bearcamp, at the Rake factory, the rocks are again well shown, running S. 70° W. and dipping N. W. from 30 to 50°. Upon Chatham Hill (see tracing No. 1), are found Nos. 46, 47 [plumose mica and graphic granite]: but the rocks are arranged in a confused manner at this point. At Chocorua, in the Swift River Valley and all along through Conway and North Conway, we find the principal rock to be (Nos. 45 (A) and 13), a coarse granite with little or no mica. The same rock, or one very much like it, occurs at the southern base of Kiarsarge; but does not appear to extend higher up than four or five hundred feet above the base of the Mountain. The

"Ledges" opposite North Conway, are chiefly, if not entirely, of granite of various degrees of fineness. The vertical striped appearance of these ledges is due to the water which runs down over them, as far as I could judge, and does not show structure. The granitic rocks through the whole of this region are much cut up by joints, but whether any true bedding can be made out is doubtful. The five summits east of North Conway village, called the Green Hills, as also the "Ledges," and, in fact, all exposures of rock in this region, show what might perhaps be called horizontal or nearly horizontal stratification; but this bedding, if it is such, must not be confounded with an apparent bedding caused by a scaling off of the rock in concentric layers, from five to ten feet thick, an example of which may be seen in the upper part of the large or south ledge (White Horse ledge). Over the whole region from Jackson to Tamworth, and far over into Maine, there is seen a well marked orographic feature which *may give* a clue to the arrangement of the rocks in this district. I refer to the general outline of the hills; which present almost universally a long gentle slope to the N. and an abrupt face to the S. The dip of the rocks, too, where this can be made out is almost always from 20 to 80° to the *North* the *N. W.* or the *N. E.*

The same granite which appears at Chocorua, in the Green Hills, and all along through Conway, is found at Kiarsarge village, and in the lower part of the mountain itself. About 500 feet above the south base of Kiarsarge, and in the old foot-path (that of 1848) occurs a ledge of clay slate, directly above the granite. This formation does not seem to extend far, as it is not found in either of the new paths up the mountain, and a very short distance from its lower boundary we pass beyond it and come upon the rock of which the upper 2000 feet of Kiarsarge appears to consist, viz: a conglomerate, breccia, or something like it. (See No. 7, and also the various pebbles included in the rock and numbered 5.) The greater portion of the included fragments are slaty, lying at all angles, and are angular, and range in size from an inch to a foot in diameter; but the pebbles (Nos. 5) many of them rounded, also occur very frequently, and were all taken from the rock in place. The slate above referred to runs N. 70° E. S. 70° W., and dips from 50 to 80° N. W., being much twisted on the small scale. It does not appear either in the old or new roads, but the path of 1840 crosses over the ledge. Five hundred feet north and south and one thousand feet east and west seems to include the whole exposure, though farther examination may detect it elsewhere. The upper part of Kiarsarge shows two well-marked systems of joints, which seem to affect nearly the whole mountains. At the top, one set runs S. 60° W. and dips about 80° N. W., the other set runs N. 55° W. and dips about 80° S. W. It will be observed that the first set agree almost exactly with the strike and dip of the slate in the lower part of the mountain. In many places on the upper part of the mountain the rock has a thin bedded sort of structure parallel to the joint planes; but whether these divisions indicate a real highly inclined bedding remains to be seen. The upper three-fourths of Kiarsarge I should in no way call granite, as Jackson does: but the specimens show what the rock is. It is also quite plain that *rounded* pebbles of various sorts of rock occur in the whole upper part of Kiarsarge.

At Goodrich's Falls, in Jackson, the jointing and quasi-bedding of the

granite is very well seen from above the bridge to below the falls. One set of joints runs N. 80° W. and dips steep to the N. The other set runs S. W. The granite at this pace decomposes in a remarkable and instructive manner: showing the original structure of the rock better by the decay than by the solid ledge. (See sketch.)

Going towards the Glen, from Jackson, at about two miles above Jackson, ledges appear on the west side of Ellis River of the rock Nos. 17-18, running S. 33 W. and dipping N. W. about 45°, and cut by joints running S. 75° W. and dipping about 80° S. At many points along both road and river the same formation is seen; and at Fernald's, five miles above Jackson, it is particularly well exposed running S. 33° W. and dipping 25° N. W. The rock at this last place [belongs to the White Mountain series]. At Glen Ellis Falls, eight miles above Jackson, [gneiss] is found with a slight dip towards the N. Just above the stopping place at Glen Ellis Falls, on the east side of the road, the slates are again seen running N. 30° E., S. 30° W. and dipping about 50° N. W.

At Crystal Cascade, three miles south of the Glen and west of the road, the slates are disturbed and twisted in a remarkable manner, and much mixed with other rocks. At the little foot bridge below the cascade the rock is granitic. Just north of the Glen House, in the road, the slates are seen again running N. E., S. W., and dipping 30° N. W.

At Jackson Falls the rock, granite, in the bed of the stream is cut by several sets of joints, the most marked running nearly N. and S. and dipping steep to the west. These joints are so general and so well-marked as to resemble bedding. Two and a half miles above Jackson on the Wildcat Branch, the rock [compact porphyritic felsite] is found in the bed of the stream, just above the bridge. At the tin mines about a mile N. E. of Jackson, and perhaps 500 feet above the river, are several openings made for ore. At the lower mine we find the main rock to be [syenitic, referred to by Mr. Huntington]; at the middle opening [dark felsite] and at the upper opening [dark quartzite]; at the last place occurs also in thin beds [a light compact feldspar.] Upon a hill on the road running to the Rocky Branch, and three miles due west from Jackson village, the rock is mica slate running E. and W. and dipping 80° N., the rock being much twisted.

The south peak of Doublehead consists of [granite.] The rock is exposed in large ledges on the south slope, and lies in broad tabular masses, with an apparent dip to the south; this is most likely the concentric scaling off of the rock before referred to. Near the top of the south peak are seen true beds running S. 60° E. and dipping 45° N. E.

In the depression just north of Thorn Mt., in the high cleaving, the rocks are very confusedly mixed, and are shown by Nos. 33 to 38 [mica schists and trachytic granite.]

With regard to surface geology, terraces and "moraine hills" may be seen in nearly all of the White Mt. valleys; but I have mapped none as yet. Perhaps the finest terrace is that upon which North Conway stands, a good section of which may be seen just below the saw mills, at the lower end of the village. This terrace, which is from 30 to 40 feet in height, consists of fine sand in the upper part, and in some places of a compact dark sand be-

neath. In the beds of some of the brooks which flow through the meadows is found the true stiff blue clay.

Glacial furrows are common throughout this region. The general course, as noted both at high and low elevations, is *south-easterly*, but cases occur where the course is *west* of S. There is but little evidence of the action of local glaciers in Bartlett and Conway, so far as I have examined the ground. I should rather conclude that the few variations from the common course of S. 15° to 30° E. were caused by the effect of local topographical features upon the general mass of ice which has moved over this part of New England.

I have as yet done little directly towards the topography of the mountain region. There are now existing three maps of the White Mountains: Bond's, Boardman's, and the County maps. The first of these was founded upon a triangulation made with great care by the late Geo. P. Bond of Cambridge, and as far as concerns the position of the principal peaks it is by far the most correct map extant; in matters of detail, however, it is not sufficiently reliable for entering geological notes. Boardman's map was intended simply as a tourist's guide. In matters of detail it is not at all accurate and it does not embrace the whole mountain region. The County maps where the country is thickly settled are tolerably correct, and are useful for entering notes; but in the fixing of the chief points, in town and county boundaries, and in details where the country is not settled, they are quite incorrect. I have thus far measured a series of angles from the summit of Kiarsarge and a part of a series from the summit of Chocorua. The results obtained are almost indentical with those published by Mr. Bond; so much so that if my notes were plotted upon his map no difference in position of the principal peaks would be seen.

Very truly your obedient servant.

GEO. L. VOSE.

MOUNT KIARSARGE.

A few more words about the geology of this mountain. The map shows the relative position of the several rocks. The coarse granite occupies the valley of the Saco and the hills south, as well as a limited band to the east, between the mountain and the Maine line. Above this most distinctly, upon three sides (the fourth has not been explored), the trachytic granite occurs. It is not abundant on the south and east, but very characteristic. On the south it crops out on the hillside below the slate. There is little to add to Mr. Vose's description of the slate. It is above the trachytic granite, and, in this respect, is like the felsites of Pemigewasset, but, unlike them, has been much twisted and reposes on the top of the terrace, inclined at a high angle. No doubt would be entertained respecting its very much later origin than the upper two thousand feet of the mountain, except that the latter is partly

composed of fragments of slate, evidently derived from this formation. The lower portions adjacent to the slate are chiefly composed of it and even at the summit small dark pieces, apparently of the same material, abound. A similar rock with dark fragments is found on Twin Mountain. The composition of the cement (Analysis XI.) shows it to be allied in character to the felsites elsewhere found overlying the trachytic granite.

A somewhat similar slate occurs between Mount Willard and Mount Lincoln. Specimens from the two localities are not distinguishable from each other, and the mass of Mount Willard is a trachytic granite. These slaty rocks pass into quartzites, if not into felsites, and cover a considerable area — including the country from Mount Willey to beyond Mount Tom, over three miles. Well-marked crystals of andalusite are found in a similar slate at the base of Mount Tom, which seems to ally the series with the andalusite slates of the Coos group along the headwaters of Ellis river, at the east side of Mount Washington. I observed that jointed planes existed in the trachytic granite parallel with the slaty strata above them on Mount Willard, like those described upon Kiarsarge. Passing to the first peak of Mount Lincoln the line of union of the granite and slate was traversed, having a compass course of N. 25° W. In the saddle of Lincoln the slates dipped 50° S. 20° W. But on the mountains south are found nothing to correspond with the feldspathic and brecciated cap of Kiarsarge. The relations of this slate to the granite and felsites demand further examination.

RELATIVE POSITION.

A few considerations will serve to indicate the probable relative positions of the rocks that have been described. The sections given of the common granite, trachyitc granite and the norian series, (or at least certain felsites,) seem to determine their relative positions, the last being at the top. The brecciated granites of Franconia seem to be older than any of these, and to underlie them as already stated, and hence there may not be any correspondence between them and the breccias made up of felsites and Labradorite. If these points are assumed, the porphyritic gneiss can be shown to be at the bottom of the series, for it lies outside of the lowest of them. Two principal ranges of this rock enter the limits of our

map. The eastern is cut off abruptly by the norian at Waterville, crossing at an angle of at least seventy degrees, and as much as fifty degrees in the dip. Another exposure of the same band of gneiss appears at the base of Mount Carrigain, standing nearly vertically. Passing from this across to the western range we travel fifteen miles. An anticlinal is hardly supposable over so great a distance. The dips have not been observed systematically, but the western range from the Pemigewasset to Moosilauk has an anticlinal form, and comes up again west of Moosilauk so as to underlie a synclinal mass of andalusite schist or gneiss. This structure agrees with its position as deduced from other facts. The andalusite rock is repeated east of the Pemigewasset in an anticlinal way, so as to correspond — as shown by its distribution on the map.

The porphyritic gneiss west of Echo Lake dips northwestwardly. At the Lake of the Clouds the dip was not measured; on the ridge running south it dips 50° easterly. Below Walker's Falls it stands nearly vertical. Our notes represent a feldspatho-hornblendic rock in horizontal plates immediately contiguous on the east, most likely lying upon the edges of this gneiss. If this prove correct then the rest of the intermediate space to the crest of the range will be found occupied by the trachytic granite, the horizontal plates showing its beginning. If the horizontal position of the granites and felsites are to be regarded as produced by original deposition, then the elevation of the gneiss took place first, and this mass of mountains has been scarcely disturbed by elevating forces since that time.

The porphyritic area along the Ammonoosuc is probably a repetition of that near Echo Lake, making a synclinal axis, just as in Benton under Moosilauk. With this premiss we can infer that the gneiss of Bethlehem was found subsequently, and lies in a basin — with an east and west axis.

We cannot as yet locate the andalusite gneiss, save that it is newer than the porphyritic bands, as shown at Moosilauk. There will be abundant opportunity the coming season to compare the formation with the norian, where the two come in contact.

There is one further suggestion in respect to relative ages. The Coos group of Littleton and Lisbon passes around the west end of the Bethlehem gneiss, showing that the latter existed before either the deposition or elevation of the former. This indicates that the

whole of the White Mountain rocks are more ancient than the Coos and Quebec groups of the Connecticut valley.

Without further discussion of this interesting topic, I will proceed to present the most important analyses in our possession, of the rocks of which so much has been said. Most of them are published now for the first time.

ANALYSIS.

I. Labradorite, Waterville. By E. S. Dana.

II. Labradorite, Waterville. By E. S. Dana.

III. Chrysolite, Waterville. By E. S. Dana.

IV. Light colored feldspar from the syenitic rock of Tripyramid. By C. A. Seely.

V. Feldspar from Sawyer's Rock. By C. A. Seely.

VI. Dark compact felsite, Cape Horn, Northumberland. By C. A. Seely.

VII. Dark compact felsite, boulder, Waterville. By C. A. Seely.

VIII. Yellowish compact felsite, Berlin. By C. A. Seely.

IX. Feldspar, Mt. Pequawket. By C. A. Seely.

X. Orthoclase, Lightning Mountain, Stratford. By C. A. Seely.

XI. Orthoclase from trachytic granite, Albany. By C. A. Seely.

XII. Red feldspar from syenite of Tripyramid. By C. A. Seely.

XIII. Labradorite, Waterville. By T. S. Hunt.

	Silica.	Alumina.	Iron Oxyd.	Magnesia.	Lime.	Soda.	Potash.	
I.	51.03	26.20	4.96	—	14.16	3.44	.58	= 100.37
II.	52.25	27.51	1.08	.99	13.22	3.68	2.18	= 100.91
III.	38.85	tr.	28.07	30.62	1.43			= 100.21
IV.	59.2	28.8	tr.	—	7.40	8.54	0.6	
V.	66.6	20.4	tr.	—	2.8	7.28	5.47	
VI.	62.2	28.	tr.	—	4.6	3.34	6.	
VII.	69.6	17.8	4.5	—	4.8	3.31	4.51	
VIII.	69.2	19.6	—	—	3.	—	—	
IX.	69.6	22.6	—	—	3.4	—	—	
X.	63.2	24.	—	—	1.6	—	—	
XI.	61.6	22.2	—	—	.8	—	—	
XII.	57.6	24.6		—	3.2			
XIII.	50.30	25.10	4.23	2.95	14.07	2.65		= 99.30
XIV.	64.90	8.80	12.60	2.37	3.50	4.24	6.25	
XV.		—	—	—	—	3.959	6.525	
XVI.	52.01	26.60	4.20	—	13.30	3.50	.65	= 100.26
XVII.	51.50	25.90	5.00	—	14.29	2.95	.50	= 100.14

XIV. Red compact felsite, Albany. By C. A. Seely.

XV. Red compact felsite, boulder, Waterville slide. By C. A. Seely.

XVI. Dark compact felsite, south end of Lafayette range. By B. T. Blanpied.

XVII. Labradorite, Dry River, five miles from Mt. Washington. By B. T. Blanpied.

Remarks. The first three by Mr. Dana were published in the "American Journal of Science," January, 1872. The mean of two determinations is given except in the case of the alkalies. In No. I a very little titanic acid was present, and not separated from the alumina. The mineral taken came from the dark colored rock named *Ossipyte*, consisting mainly of the triclinic feldspar with small yellowish grains of chrysolite. It has a dark, smoky color, not iridescent, beautifully striated, fuses more readily before the blowpipe than ordinary labradorite, and is but slightly attacked by acids. The iron was determined volumetrically, and proved to be more abundant than anticipated. Mr. Dana observed grains of an iron ore under the microscope from one-fiftieth to over two hundredths of an inch in diameter, which were strongly attracted by the magnet, and hence not a part of the labradorite. Microscopic specks less than one ten thousandth of an inch in size were thought to be cavities in the mineral. The color may be explained by the presence of the iron ore. The latter mineral proved to be a very magnetic titanic iron, judging from careful qualitative tests.

II. This labradorite came from the "Notch" on Norway Brook, occurring in large cleavable masses, often half an inch long, in company with hornblende for the principal mass; besides magnetic titanic iron, a little dark brown mica and less epidote. The color is grayish white, there is no iridescence, and striations appear only after careful search. Both these analyses show an unusually large proportion of lime for labradorite.

III. One and twenty-four hundredths per cent. of manganese oxyd is not reported in the table. This chrysolite contains an unusually large percentage of iron; thought by Mr. Dana to be a constituent of the mineral and not an impurity. The oxygen ratio of the bases and silica is nearly 1 : 1, and of the iron and magnesia about 1 : 2. This is the same ratio as that usually deduced for hyalosiderite, but the mineral differs from the latter compound in being less fusible. The chrysolite is nearly infusible before the blowpipe.

The rock whence the chrysolite came is that from whence No. I was taken. The average amount of magnesia present in the whole rock is 1.82 per cent. which would give 5.94 as the per centage of crysolite present. As this assemblage of minerals has never before received a distinctive name, Mr. Dana has thought best to apply a new designation for it, calling it *Ossipyte*, after the name of the Ossipee Indians who formerly dwelt in eastern New Hampshire. This seems to be the most common of the norian rocks along Norway brook, and has also been found further north.

The analyses from III. to XII. inclusive were made by Charles A. Seely of New York, chemist of the survey. The silica, alumina and iron oxyd, and lime were first determined; afterwards the iron oxyd was separated from the alumina, and the alkalies and magnesia weighed each by itself in a new sample of rock.

IV. This feldspar corresponds well in composition with *andesite*. The rock is a compound of andesite, orthoclase and mica, or sometimes hornblende. It constitutes essentially the whole mass of the Tripyramid. At the typical locality in the Andes it is said to come from a "syenite-like rock," just as in New Hampshire. Some analyses of norian andesites from Chateau Richer in Canada, by Dr. Hunt, agree well with this.

V. Sawyer's rock is a mountain range almost cutting across Saco river at the west line of Bartlett. It is, perhaps, more like albite than orthoclase in composition, mainly on account of the greater proportion of soda present. A larger percentage of lime was anticipated. The rock is referred to the trachytic granite layer.

VI. This specimen was thought to be a compact labradorite. It proves not very unlike the orthoclase felsites, VII. VIII. XII. and XV. All these felsites, however, contain an unusual quantity of lime, such as we shall expect to find in connection with labradorite.

VII. This represents the composition of the felsites south of the Twin Mountains.

VIII comes from a different formation, north of the White Mountains.

IX. Scarcely enough of IX. is determined to enable us to speak confidently of the species to which the feldspar should be referred.

On account of the fineness of the texture the analysis is given of the whole rock, rather than of separate crystals.

X. The rock from whence this feldspar comes closely resembled labradorite superficially. It proves to be orthoclase, and the accompanying mineral is quartz, and not chrysolite. The locality is far south of the usual norian rocks, and rests upon granite like that of Franconia.

XI. The singular texture of the trachytic granite of Albany made its analysis desirable. The crystals of feldspar scattered, through it are judged to be orthoclase. The rock apparently resembles that denominated "granitoid trachyte" by Dr. Sterry Hunt, from the province of Quebec. The red feldspar (XII.), from the syenite of Tripyramid, accompanies IV. The analysis is not yet quite complete. Dr. Hunt and Prof. Dana have remarked sufficiently upon XIII. in their letters. The large amount of iron in XIV. shows why the rock is red, and the analysis shows that the rock is not jasper, as at first supposed, but probably orthoclase. [See pages 17 and 19 for the localities of Analyses XVI. and XVII.]

THE STATE MAP.

In a previous report your State Geologist set forth the necessity of a good topographical map of the state as a basis for the proper delineation of the results of the survey, as well as for ordinary purposes by the public. With the approval of the governor and council an effort has been made to collect materials for a map drawn upon the scale of two and a half miles to the inch, in connection with the regular work of the survey. Two years since it was thought that the information gathered might be compiled into a very satisfactory map, such as is called for by the wants of citizens and the great throng of summer visitors. Parties were found who were willing to join with the state authorities in engraving such a map, provided that the topographical parts should be etched on copper. The Legislature did not adopt this proposition on account of the expense involved. At the ensuing session a proposal was made that the state undertake the preparation of a new map, and that each town should survey its own territory, sending the results to a commissioner appointed by the governor and council. This proposal failed to meet the legislative approval for a similar reason. Hence your geologist cast about for

other methods of completing the publication of a reliable map. Fortunately Messrs. Sanford and Everts, publishers of the Strafford county map, of His Excellency Governor Weston's map of Manchester and the delineation of the southern part of the state prepared for the New Hampshire Fire Insurance company, had taken a great interest in the publication of maps, and were disposed to push forward the project of publishing a map of New Hampshire by subscription. Arrangements have therefore been made by which they will publish the materials that have been collected, including that held by the proprietors of the county maps. Hence we may expect, a twelvemonth from now, a topographical atlas of the state, which will be brought to the notice of all who may desire to secure copies for themselves. The publishers, however, do not feel authorized to engrave the map on copper, because of the great expense of metal over stone work. If aid could be furnished by the state in furtherance of this object, the publishers would greatly improve the style of the map, while the public authorities might control the use of the plates hereafter.

Last year I mentioned that Congress had authorized the Coast Survey to extend their triangulation into the interior of those states which were carrying on geological surveys. This task in New Hampshire has been executed the past year by Prof. E. T. Quimby, and the results have been forwarded to Washington. During the coming summer the work will be prosecuted yet more energetically under the same administrator. Professor Quimby has kindly volunteered to determine the exact latitude and longitude of all points where signals may be placed by individuals in the central part of the state, and it is to be hoped that there will be numerous responses to his circular.

THE FINAL REPORT.

So much progress has been made by our explorations, that in pursuance of the Legislative Act authorizing the survey, we have commenced the preparation of our Final Report. This will be written as rapidly as our knowledge of the facts will permit. The plan laid out is something as follows:

PART I. PHYSICAL GEOGRAPHY.

a. Orography, or the delineation and study of the mountains.

b. Cartography, or history of the map literature of the state.

c. Distribution of the plants and trees, as related to Geological History.

d. Distribution of the animals, as related to Geological History.

e. Magnetography, or the discussion of facts relating to terrestrial magnetism, variation of the needle, etc.

f. Climatology.

g. Geology as related to Scenery.

h. History of White Mountain Exploration.

i. Tables of altitudes.

PART II. STRATIGRAPHICAL GEOLOGY.

Introduction. Relations of tho Geology of New Hampshire to that of New England.

A. Description of the Geology of the Schistose Region of the Hydrographic Basin of Connecticut River. 1. Underlying granites; 2. Gneiss; 3. Norian rocks, including eruptive syenites; 4. Metamorphic Quebec Group of Logan, or Upper Huronian of Hunt; 5. Coos Group—this embraces, (*a*) quartzite, (*b*) limestone, (*c*) mica schist, (*d*) staurolite schist, (*e*) wrinkled schist, (*f*) decomposing slates, (*g*) calciferous mica schist, (*h*) dikes; 6. Clay slates; 7. Helderberg limestones and slates.

B. Description of the Central Gneissic Region. This must embrace numerous divisions whose relative chronology is undetermined at present. 1. Porphyritic gneiss: 2. Bethlehem gneiss; 3. Gneiss about Winnepisseogee Lake; 4. Gneiss carrying large beryl-bearing veins; 5. Gneiss subdivided by bands of quartzite in the more southern part of the state; 6. White Mountain gneiss; 7. Granites; 8. Norite rocks including syenites; 9. Andalusite slates; 10. Igneous rocks.

C. Description of the Geology of the Coast Region.

D. Description of thirteen sections crossing the state in east and west lines.

E. Economic Geology. 1. Building Materials—Granite, slate, flagstone, limestone, soapstone, clay for bricks, etc.; 2. Use in the arts—enameled slate, quartz and feldspar for glass, mica, soapstone, serpentine, plumbago, precious stones, fluor spar, polishing powder, moulding sand, ochres for paints, etc.; 3. Agricultural—peat, marl, phosphate of lime, limestone, scythe stones, etc.; 4. Chemical—Copperas, alum, titanium, arsenic, and the metals gold, silver, copper, iron, lead, manganese, tin, molybdenum, zinc.

PART III. DYNAMICAL AND THEORETICAL GEOLOGY.

a. Elevation of mountains.

b. Metamorphism.

PART IV. MINERALOGY.

PART V. MICROSCOPY.

Both micro-petrology, or the study of the rocks under the microscope, and the examination of beds of polishing powder, etc.

PART VI. PALEONTOLOGY.

PART VII. SURFACE GEOLOGY.

The proper treatment of all these topics will require a book of quarto size, of several hundred pages, and an atlas of maps, with other illustrations.

ALTITUDES.

The levelling along Connecticut River has been farther prosecuted. The work above Hanover was performed last summer under the direction of A. F. Reed, of Groton, Mass., assisted between Hanover and Lancaster by Dr. Nathan Barrows, of Meriden, and between Lancaster and Connecticut Lake by Messrs. C. F. and F. A. Bradley, of the class of 1873, Dartmouth College. The results are given below. We hope to complete the gap between White River Junction and Brattleboro the coming season.

Frequent application has been made to us for heights of various points, and therefore it seems desirable that such as have been well measured should be given, together with a statement of the surveyor and the method employed. These are compiled from a more copious list in our possession:

Heights along the Concord and Portsmouth Railroad.

Levelled by Frank Woodbrige, in 1870, for the Geological Survey.

On Monday, May 2, 1870, the mean tide at the Great Bay R. R. bridge, measured 10.7 feet below the bottom of the rail. The following heights are above the mean tide at Great Bay for this day:

	Feet.
Newmarket Junction	51.916
Littlefield's Crossing	126.053
Epping	154.147
Raymond	197.881
Candia	445.190
Manchester, center of depot	180.832
Top of dam at Manchester	176.980
Amoskeag base line	108.980

Survey used in the Construction of the Road.

Level water at Great Bay Bridge	0
Newmarket Junction	48
Piscasset River, (water level) S. Newmarket, 68; track	73
Epping Depot	144
Lamprey River, (water level)	141
Same at Raymond	173
Raymond Depot	191
Outlet of Jones Pond, (water level)	258

	Feet.
Road at Patten's Shingle Mill, Candia	373
Level of ground at do., ...	354
Brook east of Candia Depot, (water level)	410
Candia Depot	445
Carr's Crossing, Candia	485
Summit at Kinnecum's Swamp	528
Turnpike at Rowe's Corner	453
Sawyer's Pond	419
Lakin's Pond	307
Suncook River	208
Railroad over Suncook River	258
Summit in Candia on R.R. after construction to Manchester	465
Auburn Depot	289
Massabesic Pond	255
Summit between Massabesic and Merrimack River at J. P. Eaton's	344

By another Route.

Bean's Island, Candia	275
Lamprey River, Candia Village	301
Highway in Candia Village	310
Summit	550
Turnpike near Rowe's Corner	450

A Survey through Deerfield.

Quincy Pond, Nottingham	288
Summit between Quincy Pond and Lamprey River . .	406
Summit	576
Suncook River, Beech Street	259
Suncook Village	281

Suncook Valley Railroad.

Furnished, by the Hon. S. N. Bell, President, from surveys of Hon. J. A. Weston.

Assume level of track at Bridge over Suncook River as .	235
Highway crossing near Suncook House	295
Highway crossing near Tennant's S. M., ...	300
Highway crossing Buck St., Allenstown	335
Bear Brook, (water level)	290
Highway crossing at Jenness Corner	335
Mouth of Little Suncook River	334
Chichester Pine Ground, (R. R. crossing)	372
Highway crossing near Webster's Mills	410
Pittsfield Depot	495

Additional surveys of J. A. Weston.

Railroad track at Pittsfield, 299 feet above track at Hooksett water station; railroad track at Alton, 322 feet above the same; summit between Pittsfield and Alton, 508 feet above the same.

The following elevations are above the railroad track at the Manchester Depot:

	Feet.
Railroad track (Manchester & No. Weare) at Goffstown,	123.26
Railroad track (Manchester & No. Weare) at Parker's Station,	137.86
Piscataquog River at Parker's Station, Goffstown	117.86
Piscataquog River below bridge at New Boston Village	241.00
Piscataquog River at west line of New Boston	333.80
Francestown Turnpike near northeast corner of Lyndeborough	432.70
Forrest road south of Greenfield Center, (summit in railroad survey)	734.86
Meadows between Greenfield and Peterborough and near Greenfield,	635.00
Contoocook River above stone bridge and dam at Peterborough Center	553.00
Meadow on Goose Brook above West Peterboro'	746
Long Meadow on Goose Brook in Hillsborough and Dublin,	779
North Pond in Harrisville,	1037
Summit on railroad survey in Harrisville	1084
Mud Pond in Harrisville,	1075
Reservoir at head of "Gulf" in Marlborough,	956
Cheshire railroad near arch bridge at So. Keene,	777
Summit on preliminary survey of Monadnock R. R. in Rindge,	883
Cheshire railroad track at State Line	750
Cheshire railroad track at Winchendon Depot,	826

Heights along Northern Railroad.

Assuming Concord Depot to be 252.39 above mean tide.

Fisherville Bridge	267.89
Boscawen	273.89
North Boscawen	290.01
Webster Place	295.26
Franklin	363.26
East Andover	661
Andover	628
Potter Place	653
West Andover	677
South Danbury	732
Danbury	826
Grafton	848

	Feet.
Grafton Center	871.05
Tewksbury Pond	904
Orange Summit	990
Railroad at Mud Pond	957
Canaan	956
West Canaan	813
Enfield	768.34
East Lebanon	765.63
Lebanon	510.31
West Lebanon	376.13
Bridge over Connecticut River	376.13
Connecticut River, high water	352.84
Connecticut River, low water	330.07
White River Junction	369.23

Surveys along Connecticut River.

Canal survey in 1825, made under the direction of Holmes Hutchinson, Esq., and communicated by Dr. E. E. Phelps, of Windsor, Vt., Hartford, Ct., taken as the initial point, or zero:

Foot of Turner's Falls, near Greenfield	91
Mouth of Miller's River, Northfield, Mass.	154
Head of Stebbin's Island, Hinsdale	165
One mile north of Westmoreland Village	178
Mouth of Cold River	193
One mile below Little Sugar River	248
One mile below Chase's Island	260
One mile above Hart's Island, Plainfield	272
One mile above Lyman's Bridge, West Lebanon	296
One mile above Orford Village	337
Two miles above Haverhill Village	347
One-half mile above Howard's Island	364
Dodge's Falls	376
Foot of McIndoe's Falls	391.5

Surveys of Vermont Central Railroad.

Height given above Lake Champlain on original profile, to which 92 is added to give height above the ocean:

Windsor	322.8
Hartland	412.8
North Hartland	379.6
White River Junction	340.7
White River Village	376.2
Woodstock Station	420
West Hartford	414.4

Survey by A. F. Reed, 1871,

Taking White River Junction as 369.23, and following Passumpsic Railroad.

	Feet.
Railroad, Norwich, Vt.	406.300
South end of bridge over Pompanoosuc River	409.027
Crossing near Mr. Blood's, Norwich, minimum grade	395.064
Crossing one and one-fourths mile south of East Thetford	410.145
East Thetford Depot	413.325
North Thetford Depot	401.741
Crossing one and one-half miles north	420.233
Crossing two and one-half miles north	435.741
Crossing one and one-half miles south of Fairlee	432.781
Fairlee	437.952
Water House, railroad, Sawyer's Mountain	449.439
Piermont Station	439.627
Bradford Station	410.007
Crossing two miles south of Haverhill	408.912
Chamberlin's Crossing	409.071
Hall's Brook	410.027
Haverhill Depot	412.142
Crossing to Newbury Bridge over Connecticut	413.857
Newbury Depot	426.002
Wells River Depot	442.898
Crossing three miles north	437.642
Ryegate Depot, platform	471.710
Crossing one mile south of McIndoes	494.895
McIndoe's Depot	487.913
Barnet Depot, last point measured on the railroad	467.114
Hay scales, Upper Waterford	752.368
Bridge, Upper Waterford, 15 feet above water	689.046
Piazza, Sumner House, Dalton	895.653
Top of stone hitching post, south end of Dalton post office	910.108
Door of County House, Lancaster	864.944
Hay scales, Northumberland.	862.852
Bridge over Ammonoosuc River, Groveton	880.170
Groveton Depot, (Grand Trunk Railroad)	898.410
Railroad Bridge two miles above Groveton	903.133
Stratford Hollow Depot	874.888
Stratford, flag station	877.742
North Stratford Station	912.684
Columbia Bridge	1008.768
Colebrook Bridge	1023.174
Middle of window on school house five miles north of Colebrook	1076.284
East end of Canaan Bridge over Connecticut River	1051.199
Bridge over Hall's Stream	1095.463
Foundation of red school house at the "Hollow," six miles from Connecticut Lake	1492.470
Connecticut Lake	1616.106

Elevation of points on and along the Portland and Ogdensburg Railroad.

Obtained by spirit level from a datum base, at mean low water of Casco Bay, as established by engineers of U. S. C. S. Initial point of distances at the west end of P. and K. Railroad Co's freight house, in Portland, Me. Furnished by John F. Anderson, Engineer of P. and O. Railroad:

Localities in Maine.

	Distance in miles.	Height in feet.
Surface of Presumscot River, on ice	5.04	43
Surface of Presumscot River, on ice . . .	13	134
Surface of Sebago Lake, on ice	17	267
Steep Falls of the Saco River (village) .	[illegible]	[illegible]
Surface of the Saco River, at mouth of the Ossipee	32	[illegible]
Surface of Ingalls's Pond near head of Great Falls, Saco River	35.4	354
Fryeburg Station, natural surface of plain	48.7	424
Highway at state line, Maine and New Hampshire	51	455

Localities in New Hampshire.

	Distance in miles.	Height in feet.
Saco River at R. R. crossing, Conway Centre	55.25	416
Surface of North Conway Village, Terrace Plain . .	60	525
Saco River at junction of the Ellis River . .	[illegible]	[illegible]
Saco River at junction of the Rocky Branch . . .	[illegible]	[illegible]
Surface of Plain of Upper Bartlett Village . .	70.5	664
Saco River at line between Bartlett and Hart's Location	72.5	749
Surface of Sawyer's River at Highway Bridge .	[illegible]	[illegible]
Surface of Nancy's Brook at Highway Bridge .	76.2	1067
Highway at Willey House	82.2	1327
South end of Gate of Notch	84.3	1823
Crawford House	85	1903

CONWAY, April 10th, 1872.

C. H. HITCHCOCK, ESQ.,—*Dear Sir:* I send you the following statement, of the elevations of several points on our Portsmouth, Great Falls and Conway Railroad, verified by a direct course of levelling from middle tide water at Portsmouth. All levels taken on top of the rail in front of the passenger houses and refer to half tide or ocean level:

	Feet.
Brock's Crossing station, 10 1-2 miles from Portsmouth, by P. S. and P. Road	94
Great Falls station, 16 1-2 miles from Portsmouth, about 12 feet higher than dam	178
Rochester Station 23 miles level plain	226
Milton Station, say 6 feet higher than three-ponds, 31 miles	415
Wakefield Station (summit 42 1-2 miles) perhaps ten feet lower than the Village street	690
East Wakefield (summit) 46 1-4 miles	678
Ossipee 1-4 of a mile from village, 54 3-10 miles . .	642

	Feet.
Summit 1-4 mile farther on, 54 1-2 miles	654
West Ossipee, 64 3-4 miles on flat land in vicinity of Ossipee Pond and near the hotel of H. T. Banks, perhaps 20 feet higher than pond 3 miles off	428
Madison, 69 1-2 miles, north west end of 6 mile pond (Silver Lake)	476
Summit, 71 1-4 miles (No. Station)	516
Conway Corner (Shatagee) west end of village, 76 6-10 miles	466
Crossing Saco River, summer level, 80 miles	446
North Conway Station, 9 feet lower than the Plain, 82 miles	516
Jackson, on the road between the two bridges, 90 miles from Portsmouth	759

Respectfully,

T. WILLIS PRATT, *Engineer.*

Heights of several points above Tide Water between Boston and the Connecticut River near Charlestown, N. H., via Lowell, Nashua, Wilton, and Forest Road.

Mostly from levels taken under the direction of Geo. Stark, communicated by M. W. Oliver, Engineer B. L. & N. R. R.

Merrimack St. Depot, Lowell	87
Lowell Depot, Nashua	123
Main St., East Wilton	323
Near Hotel in Greenfield	830
Contoocook River on Forest Road between Greenfield and Hancock	635
Hancock St., between Church and Academy,	821
Water in Hancock Pond	787
Rye Pond, S. W. corner of Antrim	1230
Bridge on the Keene and Concord Road, east of "Box Tavern," Stoddard	1218
Upper or principal Island Pond, Stoddard	1243
Summit north of Wilson's	1555
Junction of Forest and Keene Roads near Marlow	1183
Pond at Marlow	1118
Junction of Old and New Forest Roads	1328
Gustin Pond	1245
Forest Road Bridge over Cold River	614
Sills of Universalist Meeting House, Paper Mill Village	470
Low-water mark, Connecticut River at Ingersoll's Bridge	237
Peterborough Village	685
Spofford's Gap, between Temple and Kidder Mountains in Temple	1460
Hedgehog Gap, probably between Temple and Pack Monadnock Mountains in Temple	1452

	Feet.
Railroad at Mason Village	798
Hay Scales at New Ipswich	939
Harrisville	1178
Arlington Mass.,	36
Lexington Common, Mass.,	217
Bedford, Mass.,	170

The following are selected from a very large number on the E. & S. R. R., furnished with the following on Exeter River, by J. J. Bell, Esq., of Exeter:

Epping Depot	245.8
Junction with C. & P. R. R., 5000 feet east of Depot	235
Summit before reaching Piscasset River	244
B. & M. R. R. Depot, Exeter	153
Fifth crossing of Little River and lowest point,	117
Old road to Newburyport, north of Brown's	163
Hampton Falls River below Mill	136
Eastern R. R., a little below Salisbury Depot	123

On Exeter River, from Exeter Manufacturing Co's. survey in 1830. Base line, low tide, Exeter river, at the Village:

Exeter, both Dams	21.33
Rockingham Factory	34.29
Pickpocket	56.61
Copyhold, upper dam	113.14
Clarke's dam	178.57

This is the height of Phillips's Pond in Sandown, the head of the river.

Grand Trunk Railroad.

Height above datum line, 50 feet below tide, Three Rivers.

Line between Maine and New Hampshire	733
Shelburne	743
Gorham	833
Berlin Falls	1055
Milan Water Station	1100
West Milan,	1035
Stark	992
Northumberland	[illegible]
Stratford Hollow	897
North Stratford	935

Few Altitudes from Wells Water Power of Maine.

Umbagog Lake	1256
Mt. Carmel	3711
Crown Monument, corner between New Hampshire, Maine and Canada	2569
Northwest head of Megalloway River	2917

Merrimack River.

J. B. Francis of Lowell, Mass., furnishes the following altitudes along the Merrimack River:

	Feet.
Top of Dam at Pawtucket Fall, Lowell (above high water)	82
Top of Essex Co's dam, Lawrence (above high water) .	34
Surface of River at N. H. state line (above high water) .	86

Cheshire Railroad from Profile.

Height given from base line at Ashburnham Junction, Massachusetts. This is probably about fifty feet below Ashburnham Summit, on the Vermont and Massachusetts Railroad, which is 1,196 feet above the ocean. The signs + or — will indicate the relations of each point to the base line.

Ashburnham Summit	+ 70
North Ashburnham	+ 31 1-2
Winchendon	— 23
Winchendon Summit	+ 0.27
State Line	— 117.23
Lowest Point	— 122
Track at Collins Pond	+ 57
Fitzwilliam	+ 54
Fitzwilliam Summit	+ 143
Troy	— 7
Marlboro'	— 119
Keene	— 509
Surry Summit	— 270
E. Westmoreland	— 390
Westmoreland	— 585
Walpole	— 815
Bellows Falls	— 839
Mt. Kearsarge as measured by J. R. Eastman, corrected for his base line in Andover	2742

A few Heights from Jackson's Report.

Mann's Hotel, Randolph, above Lancaster	492
Lime Pond, Columbia, above Chamberlain's Hotel, Colebrook	380
Summit of Road, Dixville Notch, above do.	835
Locke's Tavern, Epsom, above the ocean	443
Deerfield	494
Greenfield	418
Kingston Tavern	70
Temple Mountain above Temple Hotel	814
Mt. Whiteface, above McCrillis House, Sandwich	2941
Mt. Pequawket	3358
Sunapee Lake	1080
Ossipee Mountain	2361
Gunstock, W. Peak, above Lake Winnipiseogee	1561

	Feet.
Gunstock N. Peak, above Lake Winnipiseogee	1969
Symmes' Hill, Hancock	496
Catamount Hill, Pittsfield	1415
Wingate's Strafford	748
Blue Mountain	1151

Boston, Concord and Montreal Railroad.

These figures were taken from Guyot's Memoir on the "Appalachian Mountain System," adding fifteen feet so as to make the starting point at Concord the same with that determined specially by the survey:

Meredith Village	557
Plymouth	488
Rumney	535
Warren	751
R. R. Summit	1078
E. Haverhill	788
Woodville	463
Connecticut River, low water	422
Bath	536
[illegible]	[illegible]
Littleton	832
Whitefield Summit	1072
Whitefield Village (not R. R.)	972
Lancaster	875

The following altitudes are copied from Guyot's Memoir upon the "Appalachian Mountain System." B. signifies mercurial barometer; P. L., pocket level; L., by levelling:

The Mt. Washington Chain.

B. Mt. Madison	5365
B. Gap between Madison and Adams	4912
B. Mt. Adams	5794
B. Gap between Adams and Jefferson	4939
B. Mt. Jefferson	5714
B. Gap between Jefferson and Clay	4979
B. Mt. Clay	5553
B. Gap between Clay and Washington	5417
B. Mt. Washington	6293
B. Gap between Washington and Monroe	5100
B. Lake of the Clouds	5009
B. Mt. Monroe	5384
B. Little Monroe, W.S.W. of Monroe	5204
B. Mt. Franklin	4904
B. Gap between Franklin and Pleasant	4400
B. Mt. Pleasant	4764
B. Gap between Pleasant and Clinton	4050
B. Mt. Clinton	4320

Various points about the Mountains.

		Feet.
B.	Bethlehem Village	1450
B.	Pierce's bridge over the Ammonoosuc	1221
P.L.	White Mountain House	1551
B.	Fabyan site (old house)	1583
B.	Cherry Mountain, summit of road	2192
P.L.	Cherry Mountain, approximately	3670
B.	Summit of road between Moose and Israel's Rivers	1446
B.	Peabody River, path crossing near Glen House	1543
L.	Glen House	1632
B.	Pinkham Notch summit, near Glen Ellis Falls	2018
B.	Hotel at foot of falls, Jackson	771
B.	Mt. Deception, near Fabyan's	2449
P.L.	Wild Cat Mountain	4350
P.L.	Mt. Carter, south peak	4830
P.L.	Mt. Carter, north peak	4702
P.L.	Mt. Moriah	4653
P.L.	Crawford Mountain	3134

Mountains in "Pemigewasset."

P.L.	Echo Mountain, highest point	3170
P.L.	Willey or Notch chain, lowest or 3d N.W. peak	4070
P.L.	Middle or highest peak about	4330
P.L.	Willey Mountain proper, front or east peak	4300
P.L.	Twin Mountain, the highest peak	4920
B.	Mt. Carrigain	4678
B.	Summit of eastern spur	4419
P.L.	Brick House Mountain, in the line N.E. two miles from Carrigain	3850
P.L.	Hancock Mountain (called Pemigewasset by Guyot)	4420
P.L.	Tremont Mountain	3393
P.L.	Green's Cliff	2958
P.L.	Table Mountain, three miles S.S.E. of Hart's ledge	3305
P.L.	Sandwich Dome, above Campton	3969
P.L.	Mt. Osceola, Waterville	4397
P.L.	Mt. Passaconnaway	4030
P.L.	Tripyramid	4086
P.L.	Chocorua	3540

Franconia Region.

B.	Franconia Iron Works	979
B.	Profile House	1974
B.	Franconia Notch	2014
B.	Echo Lake	1926
B.	Cabin, foot of Mt. Lafayette	1780
B.	Flume House, road in front	1431

		Feet
P.L.	Eagle Cliff, facing Profile House	3446
B.	Eagle Head, near the pond	4216
B.	Eagle Pond, foot of last peak	4170
B.	Mt. Lafayette	5290
B.	Mt. Lafayette, south peak, "Mt. Lincoln" of Fifield	5101
P.L.	Blue Mountain, summit of Kinsman range	4370
P.L.	Mt. Kinsman about	4200
B.	Mt. Cannon, approx	3850

Other Localities.

B.	Moosilauk	4790
P.L.	Carr's Mountain	3480
P.L.	Owl's Head	2950
B.	Merrill's House, base of Moosilauk	1681
B.	Thornton, (west?) opposite P. O.	1223
	Railroad and canal, Lake Winnipisseogee, mean level	501
B.	Eastern summit of Red Hill	1769
B.	Western summit of Red Hill	2025
	Mt. Monadnock	3718

Barometical Measurements by J. H. Huntington, in 1870.

Water shed between east branch Pemigewasset and New Zealand River	2123
Willey Notch	2799
Second notch north of Carrigain near a pond	3224
First notch north of Carrigain	2465
Notch south-west of Carrigain	3126
Cascade a quarter of a mile east	2076
Water shed between east branch Pemigewasset and Swift River	2618
Mad River Notch	1815
Greely's Hotel, Waterville	1553
Percy Peak, north 3336; south	3149

MR. HUNTINGTON'S LABORS.

Mr. Huntington has continued his labors in behalf of the Survey during the past year. Until late in July he was occupied with the compilation of his Report upon the Geology of Coos County. He then took the field, and labored in the northern part of the state, also in Essex Co., Vt., the latter without cost to the Survey, though we receive the benefits of the exploration. In September he examined the formations near Jackson, Bartlett, Conway, Albany, etc., partly to carry on the search for [illegible]

rocks, and partly to examine the region of iron and tin, remaining in the field after the beginning of November. The winter months he spent in office work. Extracts from his report upon the iron ore in Bartlett, the search for tin, and a notice of the gold rocks in Pittsburg and adjacent formations in Canada are herewith presented.

IRON ORE IN BARTLETT.

A little south of west from the village of Jackson there is a high mountain ridge, the eastern extremity of which is known as Baldface. This ridge extends along the sea to the western slope of Mount Crawford, but it is cut by the valley of Rocky Branch, and also by a stream, Razen Branch, in the western part of Bartlett. This ridge, for the most part, is a coarse granite, composed chiefly of feldspar and quartz, but it contains some mica and generally manganese. In this granitic rock, in the northern part of the town of Bartlett, and east of Rocky Branch, occurs the most extensive deposit of workable iron ore ever found in New Hampshire.

In the ridges that project south from the ridge just mentioned, the granite is of a different texture, being more compact, and the feldspar, instead of being a light flesh color, is a dull gray, and more distinctly crystalline. This rock forms the precipitous cliffs north of the road running from Jackson to Upper Bartlett. North of the granite containing the iron, and forming the mountain south of the settlement in Jackson known as Green Hill, the rock is a mica schist, which passes into a quartzite. The schist dips N. 40° W. at an angle of 25°, and hence it rests upon the granite. On the eastern slope of the mountain is a schist entirely different from that which forms the mass of the mountains, and, besides, it has an easterly dip, and it seems probable that it is the remnant of a synclinal axis that once filled the valley of Ellis river.

This deposit of iron has been known for many years, and was first noticed by Mr. Meserve. It was visited by Dr. Jackson, and is thus described by him:

"One of the veins at the upper opening measures thirty-seven feet in width in an east and west and sixteen in a north and south direction. The second opening two hundred feet lower down the slope of the hill exposes the ore, maintaining the same width. Three hundred feet lower down the vein is observed to narrow and is but ten feet wide, and four hundred feet farther

down the width increases to fifty five feet. Five hundred and forty six feet lower still there is a small opening or cave twenty feet deep, where the ore narrows again. On searching to the westward of this great vein, at a distance of two hundred and fifty feet, we soon discovered a new one, which appears to be of the largest dimensions. . . . Forty-nine feet farther westward the soil is full of angular fragments of the ore, indicating another vein. It is evident that this mountain is intersected by a great number of veins of excellent iron ore and will furnish an inexhaustible supply. It is proper here to remark that it is composed chiefly of the peroxide of iron, combined with a small proportion of the protoxide, and it contains a little oxide of manganese. From the composition of the ore we know that it will make excellent iron and the best kind of steel."

Fifty tons of the ore were sent to Sampson & Co., celebrated English iron and steel manufacturers, who have reported favorably upon its good qualities. In my examination of this ore deposit, the measurements for mapping the property were made by Daniel Baker, Esq., of Bangor, Me. Starting from the most westerly outcrop on the slope towards Rocky Branch, we found the principal outcrops to lie in a direct line running N. 12° E., and the entire distance one hundred and seventy-five rods. The last outcrop on the east is six feet in width. Measurements of the openings on the west slope towards Rocky Branch were made by Dr. Jackson when the mine was first opened, and could be done much more exact than now. In several places, particularly north of the line followed, there are indications of iron, which may prove as extensive as the beds already opened.

An analysis of the iron ore by Mr. Williams was as follows:

Peroxide of iron	69.4
Quartz and feldspar	25.2
Oxide of manganese	2.7

69.4 of peroxide, containing 48.117 per cent. of metallic iron.

Another specimen yielded:

Peroxide and protoxide of iron	77.25
Quartz and feldspar	21.40
Alumina	.15
Manganese	1.20

Or 53 per cent. of metallic iron.

In the annexed diagram the relative situation of the principal openings are shown. A, B and C being those on the slope towards

Rocky Branch. D is the excavation on the east. The circles show sites where additional indications of ore may be seen. The vertical scale is four hundred feet to the inch, the horizontal sixty rods to the inch:

The masses of ore seem to be in vertical segregations, consequently there is more uncertainty as to their extending to a great depth, than if the ore occurred in lodes in a stratified rock, but this uncertainty is in a measure counterbalanced by the large masses in which the ore here occurs.

Until recently this ore has been far from any means of transportation by railway, but now the Portland and Ogdensburg Railroad, which extends through Bartlett, will pass within three miles of the mine, and a branch road can be easily built up Rocky Branch to a point where a tramway can be constructed to the shaft, and thus the ore can be moved altogether by steam.

The following may be considered a fair estimate as to cost of mining and profits:

200 tons of ore per day at $2.64	$528
General expense	50
Freight to Portland	300
Entire cost	$878
Value of ore at $6.00 per ton	$1,200

which leaves a margin of $322 per day as profit on a capital not exceeding $160,000.

The following is an estimate for a day provided the ore is smelted in the valley of Rocky Branch near the mine:

200 tons of ore at $2.64	$528
16,000 bushels of charcoal at $ .08	1,280
20 furnace men at $3.50 per day	70
160 laborers at $1.50	240
Limestone for flux	100
Repair, etc.	40
General expenses	250
Freight on 100 tons of iron to Portland	170
	$2,678

These figures at the present price of pig iron would leave a very large margin for profit, though the necessary outlay for the construction of furnaces, etc., would greatly increase the capital stock to be employed in carrying on the operations. The ore could probably be extracted, especially if it is done by open mining, at a much less cost than we have given in the above estimate, the location being favorable for this kind of excavation. The mine is owned by E. S. Coe & Co., of Bangor, Me..

SEARCH FOR TIN.

The relations of the rocks in Jackson are such that it has been considered a favorable locality in which there might be found workable lodes of tin. The occurrence of tin here was detected by Dr. Jackson in 1840, since that time several attempts have been made to develope the mine, but it seems that the parties have been easily discouraged as they have soon abandoned the undertaking. The following notes in regard to the working of the tin mine were furnished by Mr. Geo. N. Merrill, as also a view of the tin locality and a profile showing the situation of the schist and shafts. "The American Tin Company was chartered by the legislature of New Hampshire July 16, 1864, and they issued sixty thousand shares at $5 per share. The company secured one hundred acres of land on Tin Mountain and the mineral rights on one hundred acres adjoining. The company actually expended and paid out $4,371.69. The last work done at the mine was in August, 1865. The company sunk two shafts, one twenty-five the other forty-five feet, and made an adit ninety feet. To have reached the main shaft would have required an adit four hundred feet in length." The rock excavated from the adit is composed mainly of a triclinic feldspar, probably labradorite, and with it is an orthoclase feldspar.

Considerable time has been devoted to exploring the country from Madison to Milan, where it was supposed, from the character of the rocks, that tin might be found. In many places there are indications of metallic deposits, but for the most part they are iron sulphides at least on the surface, while a few blasts might reveal something more valuable. However well versed a person may be in mining, every new mine that is discovered has characteristics peculiar to itself and these have to be carefully studied before any one can form a correct judgment in regard to it. Minerals present themselves too under so many different phases, and

when exposed to the atmosphere are often so changed as scarcely to be recognized, that no one unless he has made explorations can form any estimate as to the time required or the labor necessary to be performed. In going from Robertson's Corner to Madison Corner just after passing the height of land south of the road we find the schist in many places pyritiferoas and often much decomposed.

There are also numerous beds of granite or possibly they may be nothing more than immense veins. The schist where it does not contain pyrites is similar to that in Jackson where tin has been found, and here it underlies the White Mountain gneiss. In Jackson, every locality where it was thought there could be any show for tin, was examined, and an analysis of many of the specimens collected has been made by Professor Seely and very rarely has there been found even a trace of tin. The most promising localities away from the old opening are in the valley immediately north of Thorn Mountain and on the west slope of Black Mountain, and the tin rocks here underlie the andalusite schists, at least on south end of Black Mountain, and apparently uncomformably. On the west side of Tin Mountain near the Dundee road the schist is pyritiferous and there are numerous beds of granite, the rocks seem to be quite similar to those on the opposite side where tin has been found. Going north, the entire western slope of Black Mountain from its base half way up seems to be composed of pyritiferous schists, beds of granite and gneiss. There is a promising locality near Mr. J. R. Harriman's, also near the place formerly occupied by J. Y. Perkins.

In Berlin, on Cate's Hill, there is a combination of minerals rarely seen on the surface, pyrite, magnetite, hornblende, tremolite, chalcopyrite and bornite. The general appearance is exceedingly promising for copper if not for tin, but we have not been able to discover any place where the ore is concentrated in a vein, though there are several places where it is disseminated through the rock. Here, as elsewhere, the rocks differ somewhat in lithological characteristics from those at Jackson where we find the rocks containing tin interstratified with labradorite, which was not seen either in Madison or Berlin. From the occurrence of labradorite on Tin Mountain, probably on Thorn Mountain, and along the Saco toward the Notch, it seems to be quite certain that we have here quite a large area of upper laurentian rock.

ALLUVIAL GOLD OF INDIAN STREAM.

In that part of Quebec Province that lies between the St. Lawrence, Maine, New Hampshire and Vermont, the existence of gold in the alluvium has been known for many years. It is estimated that the area over which it extends comprises more than ten thousand square miles. The gravel containing gold rests generally upon metamorphic schists, some of which are associated with diorites and serpentines. Mr. A. Michel compares the gold deposits of Lower Canada with those of Siberia. In the Ural and Altai Mountains the auriferous gravels are almost always found reposing on schistose rocks, very rarely granitic or syenitic, as along the Pacific in North and South America. He further says that the gold in Quebec Province "whether in large or small grains, is generally so smooth, so much rounded and worn by friction, that it appears to come from some distance. . . . . The condition of the gold shows it to have been for the greater part, at least, detached, rounded and ground by erosive action of currents of water."

In the town of Ditton which borders on New Hampshire and is immediately north of the head waters of Indian stream, alluvial gold washing, by sluicing, has been carried on for several years. The place where the most extensive operations are, is on a branch of Salmon river, three and a half miles from the boundary. The stream at first runs a little south of east, but at the point where the principal excavations have been made it turns and runs northward. So that here there is a basin in which the drift has accumulated to the depth of fifteen or twenty feet. The upper portion, which consists of a very coarse gravel and has a thickness of three or four feet, was probably deposited by the stream and it contains no gold. The portion below consists of both coarser and finer material, from clay to boulders eight or ten inches in diameter. Through this the gold is irregularly distributed but it is most abundant near the bed rock, which here consists of an argillaceous schist, quite fissile and contains numerous cavities filled with a yellowish powder. This mine has been wrought during the summer months every year since 1866, and from ten to twenty men have been employed by the proprietor, J. H. Pope, M. P.

As gold was found immediately north of New Hampshire and since the drift through which it was distributed came from the northward, the drift striæ where they were noticed being S. 28° E. there is every probability that gold will be found within our limits.

But prospecting in a wilderness ten or fifteen miles from the habitations of men, where the places can be reached only on foot, requires a great amount of time and labor, and therefore our explorations have not been so thorough as they might have been under more favorable circumstances.

In my explorations on Indian Stream I employed an Indian, Mr. A. A. Annance who was formerly a student at Hanover but who now prefers hunting moose and trapping sable to studying calculus and reading Greek. The points examined were on and near Indian Stream about three and a half miles from the boundary. The stream here is quite rapid, and on either side the hills rise three and four hundred feet above its bed, while every few rods, either from the east or west, it receives a tributary. The rocks here, as elsewhere on Indian Stream, consist of argillaceous schists. These are often so wrinkled and corrugated that it is difficult to determine the dip, while elsewhere, especially where the rock is of a coarser texture, the flextures and contortions are not seen. In every respect the rocks are similar to those of Ditton. Immediately on Indian Stream the gold is chiefly found in the fissures of the schist, which is here so fragile that it is easily broken up by picks. A quarter of a mile from the stream we found the characteristic drift of this section. It consists of a bluish clayey gravel and contains boulders of schistose rocks, and it has a depth, where we excavated, of three and four feet. The gold seems to be distributed through the entire mass, though it is nowhere very abundant, yet when the road, that was several years ago projected from Connecticut Lake to the boundary, is constructed, this section will be well worthy of a thorough exploration especially as the streams are rapid and the descent of the bed rock is sufficient to carry away the loosened sand if the hydraulic process is used. It has been estimated that *"earth which contains only the twenty-fifth part of a grain of gold, or about two mills' worth in a bushel, will pay about two dollars a day to a pipe."—*J. H. Huntington.*

OTHER WORK.

I can only refer briefly to labors in other portions of the state. Early in the season explorations were carried on by myself in Cheshire and Hillsborough counties. On the seventeenth of June, with the assistance of eleven gentlemen from the graduating class

*Mining Statistics west of the Rocky Mountains 1870. p. 478.

at Dartmouth College, the exploration of the Pemigewasset country was commenced, and continued uninterruptedly for a month. These gentlemen kindly proffered their services without charge, and deserve the thanks of the community for their exertions in our behalf. Some have imagined the party as enjoying the luxuries of the season in the cushioned seats of the well-appointed hotels about the mountains, with every want eagerly anticipated by dutiful attendants. On the contrary our houses were hastily extemporized sheds, our beds a few boughs or ferns placed upon boards, our food consisted of stale crackers and preserved meats, save a rare taste of trout and berries gathered in climbing mountains, and the luxury of an occasional basket of provisions sent by kind friends at the Profile House, and we were our own servants. The party consisted of A. A. Abbott, M. O. Adams, A. M. Bachelor, R. M. Carleton, C. H. Conant, G. E. Davis, H. C. Harrison, C. W. Hoitt, Jonathan Smith, W. Upham, A. W. Waters. All these gentlemen contributed something towards the accumulation of facts bearing upon the important questions discussed in the first part of the report. Messrs. Conant and Smith were so fortunate as to discover a new lake on the northwest side of Haystack Mountain, which has been christened Haystack Lake. It is parallelogramic in shape, fifteen rods long and half as wide, with rather shallow water, forming the headwaters of Gale River, three thousand seven hundred and eighty-seven feet above tide water as determined by the Aneroid barometer. Messrs Abbott and Bachelor succeeded in discovering a second lake still larger, upon the east side of Mount Kinsman, named as the other, after the mountain. Others of the party measured the length of the profile of the "Old Man of the Mountains," finding it to be thirty-six feet from chin to top of the head, the face itself being twelve hundred feet above the lake beneath. Soon after the disbanding of the first, a new party was formed, consisting of A. A. Abbot, W. Flint and W. Upham, with the aid of E. C. Atwood for a short period. This second party remained, some of them two months longer, exploring the country as far south as Sandwich.

I was also able to explore the shores and islands of Lake Winnipisseogee, besides making a reconnoissance of the whole country east of the lake as far as the state limits to the east and Jackson to the north. In September and October, in company with L. Holbrook, Jr., an attempt was made to trace out two bands of

white quartzite in Hillsborough, Merrimack and Strafford counties. Their importance in subdividing the gneiss was first pointed out by Hon. S. N. Bell of Manchester, who has interested himself much in following their outcrops through the country. The result of all our examination has been that these two bands of quartzite have been followed, often in a serpentine course parallel to each other, eight or ten miles apart, from Temple to the north part of Strafford on one line, and from New Ipswich to the south part of Strafford on the other. Beyond this point the formations seem to be covered by the andalusite schists. After passing a wide band of gneiss to the west of the Temple-Strafford range, we come to a belt of porphyritic gneiss, which, in accordance with the view first suggested by Mr. Bell, seems to be the oldest formation in the state. Now if this view of the relative ages of the formation is correct, then we ought to find similar rocks south from the central and older porphyritic gneiss. Our observations indicate a perfect correspondence; for the studies commenced by G. A. Wheelock, Esq., in Keene, have brought to light the two beds of the same quartzites in Keene and Surry separated by a wide band of gneiss from the central group. As the same rock appears in Grafton and Newport fifty or sixty miles farther north it is likely the same arrangement continues past the centre of the state, while the descriptions of my father in the Final Report on the Geology of Massachusetts speak of a white quartzite having the same relations, midway through that commonwealth. Neither this nor the band of porphyritic gneiss mentioned as passing nearly north and south from New Hampshire to Connecticut on the meridian of Ware were represented upon his map, as their importance was not appreciated; but we may presume that their proper delineation and connection with the White Mountain rocks will solve the long vexed problem of New England Geology.

Other explorations were made—as a careful study of the strata about Claremont with reference to the possibility of supplying the citizens with water from an artesian well, a successful search for the syenites and breccias of the norian system upon Mounts Belknap and Gunstock, and a trip to the molybdenite vein in Westmoreland and the iron ore of Piermont by Mr. Holbrook, who kindly wrote out full reports concerning their facies and value.

MUSEUMS AND MODELS.

The work of collecting specimens of the rock and minerals has also been prosecuted. Three of the sections across the state have also been measured during the past year, and samples to illustrate them been gathered and arranged upon the shelves at Hanover. The authorities of the College have increased their facilities for the exhibition of the result of the survey. I have a large number of boxes containing a portion of the collection designed for the State House packed and directed to you at the office of the survey, awaiting your orders. As you may remember, three topographical models prepared under our supervision have already been sent to you. The first is a delineation of the Mount Washington range of mountains upon the scale of one hundred and forty rods to the inch horizontally and one thousand feet to the inch vertically. The second shows the mountains of Bethlehem and Franconia upon a larger scale, and was originally prepared with a view to illustrate the theory of Professor Agassiz concerning the northward transportation of boulders by a local glacier from Lafayette and Profile Mountains. The third is the production of Mr. J. H. Huntington, and shows in relief nearly the whole of Coos county, upon the horizontal scale of one mile to the inch horizontally and one thousand feet to the inch vertically. It is our purpose to represent the whole of the state upon the same scale as the last, and we have the foundations already laid for this model in Culver Hall.

MICROSCOPY AND CHEMISTRY.

Professor Edwards has attended to the preparation of sections of our rocks for examination under the microscope and to the study of the diatomaceous earths as carefully as his other engagements have permitted. The draft of the introduction to this report has been submitted to me. Our chemist, Prof. Charles A. Seeley, has made numerous analyses whenever requested, and some of his results have been submitted. We have contributions also from E. S. Dana and B. F. Blanpied.

MOUNT WASHINGTON OBSERVATORY.

The United States government have continued their meteorological observations upon the summit of Mount Washington, since the date of my last report, and dispatches from there have been

published daily in the leading newspapers all over the country. Last year I presented full meteorological tables from the time of the establishment of the observatory till we delivered it over to the Signal Service of the War Department. For the pleasure of those interested in the results I give herewith a condensed summary of the barometrical and thermometrical observations taken upon the mountain between August 1871 and April 1872, compared with those taken at the same time under the direction of Professor Young of Hanover:

Date.	Barometer reduced to freezing point, Mt. Washington.	Barometer reduced to freezing point, Hanover.	Thermometer, Mount Washington.	Thermometer, Hanover.
August, 1871 . .	23.886	. . . .	47.6	. . .
September, " . .	23.843	29.476	36.1	52.5
October, " . .	23.765	29.432	30.5	47.2
November, " . .	23.425	29.336	12.2	28.3
December, " . .	23.350	29 348	3.2	19.1
January, 1872 . .	23.309	29.309	4.5	17.6
February, " . .	23.356	29.315	6.2	15.7
March, " . .	23.248	29.291	—1.4	18.8

ACKNOWLEDGMENTS.

Our special thanks for favors received during the past year are due to the following gentlemen and many others: His Excellency, J. A. Weston, Governor of the state; Hon. S. N. Bell, Manchester; J. J. Bell of Exeter; the trustees of the New Hampshire College of Agriculture and the Mechanic Arts; John F. Anderson, Portland, Me.; F. Willis Pratt, Engineer of the Eastern R. R.; Dr. T. Sterry Hunt, F. R. S., of Montreal, P. Q.; Prof. H. F. Walling, Boston; E. S. Coe, Bangor, Me.; S. Aug. Nelson, Georgetown, Mass.; Prentiss Dow, Claremont; Wm. C. Fox, Wolfeborough; Messrs. Taft, Greenleaf and Andrews of the Profile House, Franconia; F. G. Sanborn, Boston; C. P. Whitney, of Milford; Emmons Raymond, Lyndonville, Vt.; Gyles Merrill, St. Albans, Vt.; J. A. Dodge, Plymouth; George Stark, Nashua; H. G. Chamberlain, Concord; R. Stewart, Keene; Hon. Onslow Stearns, Concord; C. J. Brydges, Montreal, P. Q.; Henry Bailey and T. H. Cooper of the G. T. R.; J. K. Cole, Berlin Falls; L. P. Adley, Milan; E. Hicky, Stark; J. B. Melcher, Groveton; Dr. G. O.

Rogers, C. C. Brooks and F. Richardson, Lancaster: Geo. N. Merrill, Jackson; Geo. W. M. Pitman, Bartlett; Joshua Chapman, Thornton.

Respectfully submitted.

C. H. HITCHCOCK.

HANOVER, N. H., June 1, 1872.